



Eighth Edition

Human Diseases

A Systemic Approach

Zelman • Raymond • Holdaway • Dafnis • Mulvihill



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EIGHTH EDITION

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Preface

Welcome to the Eighth Edition

The eighth edition of *Human Diseases: A Systemic Approach* has been thoroughly updated and revised for accuracy, organization, and currency. A complete set of multimedia ancillaries accompanies the text and provides a multimedia learning experience. Students and instructors will enjoy the text's accessible and engaging approach to human diseases.

Every chapter has been entirely rewritten for this edition.

Organization

The text remains organized in two parts. Part I, *Mechanisms of Disease*, introduces students to terminology, immunity and inflammation, inheritance, cancer, and infectious diseases. Part II, *Diseases of the Systems*, discusses the major diseases of the body systems. Also returning is the popular *Side by Side* feature; *Prevention Plus!*; *Diseases at a Glance* charts; and *Interactive Activities*, including case studies and multiple-choice, true/false, and fill-in-the-blank exercises.

New to the Eighth Edition

- **“Healthy Aging” feature.** Throughout the text, highlights practical information about aging and disease prevention.

- **“Promote Your Health” feature.** Throughout the text, highlights useful information, tools, and behaviors that reduce the risk for selected diseases and disorders.
- **Consistent coverage of disease topics.** Throughout the text, the authors attempted to include, for each disease, information on incidence, prevalence, risk factors, symptoms, etiology, diagnosis, treatment, and prevention.
- **New chapter on Diseases and Disorders of the Special Senses.** This chapter expands and brings together in one place diseases and disorders of the eye and ear.
- **Resources/references.** Updated professional and credible resources have been included at the end of each chapter.

Instructor's Resource Manual

This manual contains a wealth of material to help faculty plan and manage the human disease course. It includes lecture suggestions and content abstracts, learning objectives, a 693-question test bank, and more for each chapter.

Image Library

A collection of 198 images is available for instructors to download for presentation purposes. This library encompasses each of the high-quality images contained in the text and may be used in any way that instructors wish.



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Jill Raymond, PhD, is a Professor in the Department of Life Science at Mesa Community College in Mesa, Arizona, where she teaches microbiology. She received her PhD in Microbiology from the University of California at Davis and completed a postdoctoral fellowship in infectious diseases at the University of California at San Diego, where she studied the parasite *Giardia lamblia*.

Dr. Raymond is proud to dedicate the eighth edition to her husband, Andy. Without his continual support and encouragement, this edition would have been almost insurmountable.

Paul Holdaway, MA, a native Hoosier, is a graduate of Indiana State University and was an instructor there for two years. He is retired from the Biology Department at Harper College in Palatine, Illinois, where Dr. Mary Lou Mulvihill was an admired fellow biologist and friend. Holdaway takes pleasure in a wide range of biological and clinical interests, as well as sports and family activities.

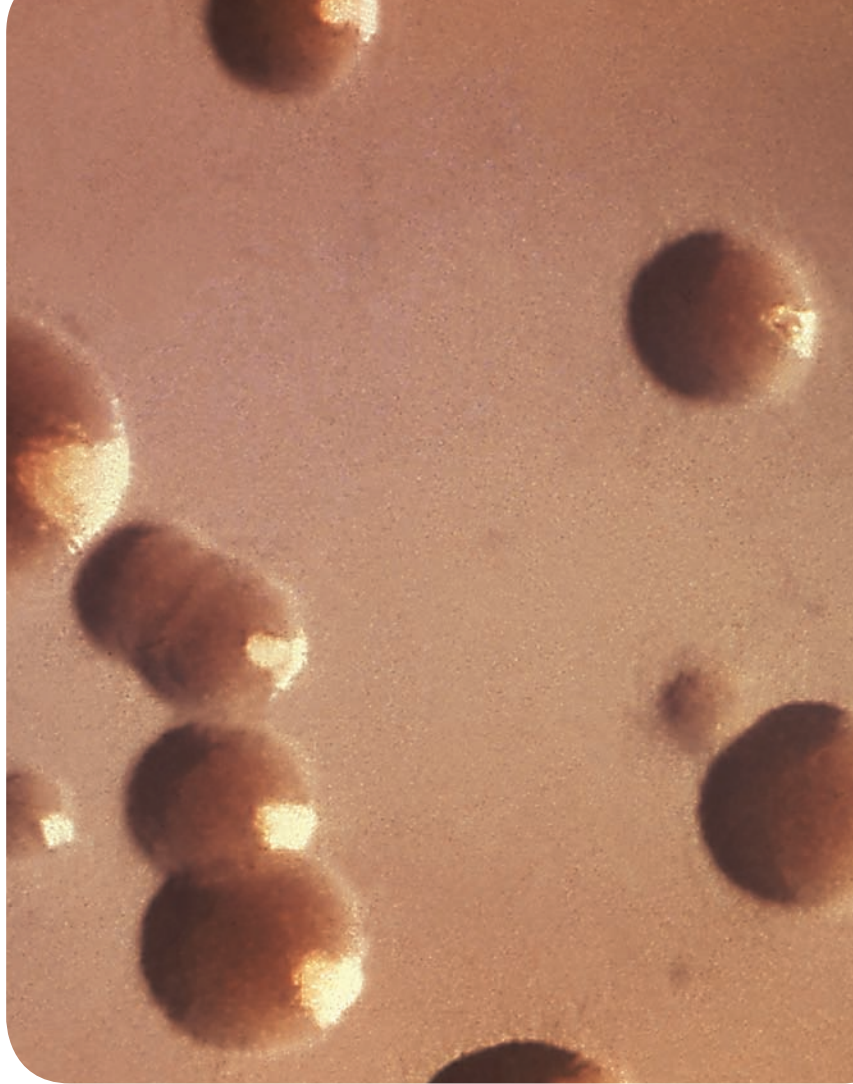
Elaine Dafnis, PharmD, MS, received her degree from the University of Illinois at Chicago. She taught courses in pharmacology, pathophysiology, pharmacy law, and pharmaceutical calculations at William Rainey Harper College and the College of Lake County in Illinois. She has served as a mentor and preceptor for pharmacy students at the University of Illinois and Drake University.

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Part I

Mechanisms of Disease

How do we define and describe disease? What causes disease? In Part I, we discuss the manifestations, terminology, diagnosis, and mechanisms of disease.



Chapters

1. Introduction to Disease
2. Immunity and Disease
3. Infectious Diseases
4. Cancer
5. Heredity and Disease

Chapter 1

Introduction to Disease

Learning Objectives

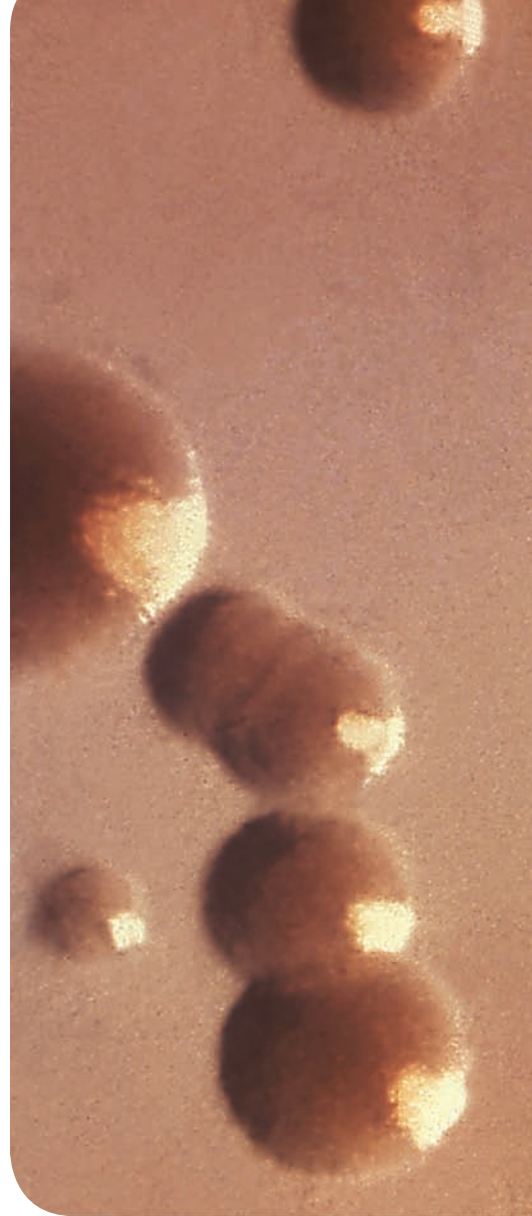
After studying this chapter, you should be able to

- Define basic terminology used in the study of human disease
- Identify the major causes of disease
- Identify risk factors related to disease
- Describe how health promotion and disease prevention reduce the burden of disease

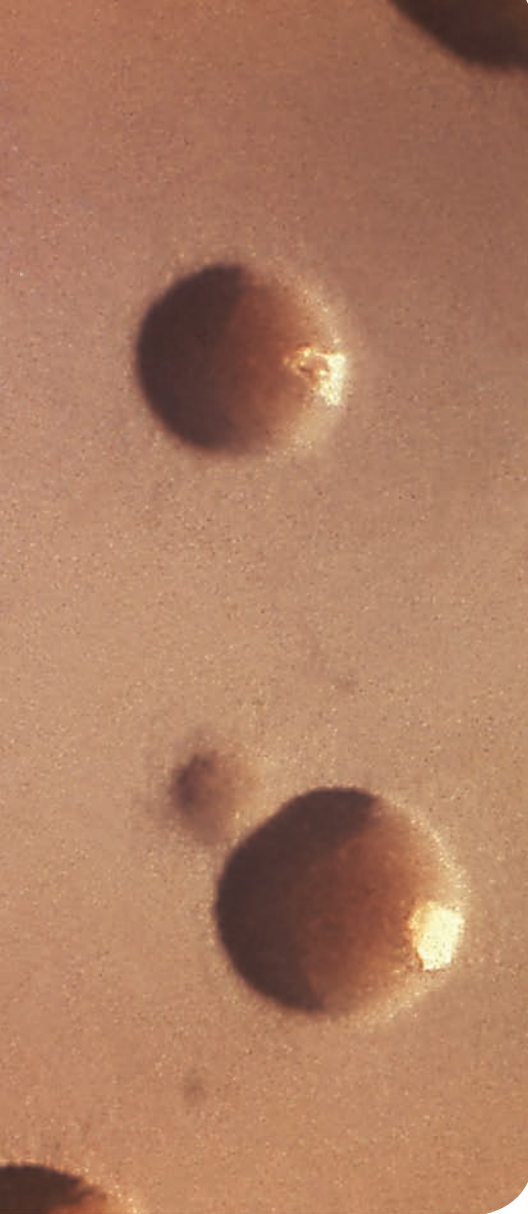
Fact or Fiction?

Plague does not occur in the United States.

Fiction: Plague first reached the western United States around 1900. In recent decades, an average of seven human plague cases are reported each year in the United States. Plague is most common in the southwestern states, particularly New Mexico, Arizona, and Colorado.



A heart infusion agar culture growing colonies of *Yersinia pestis* bacteria. (Courtesy of the CDC/Dr. Brodsky, 1966)



Disease Chronicle

The Black Death, also known as the plague, was one of the most devastating pandemics in human history. The Black Death arrived in Europe in October 1347 when 12 Genoese trading ships docked at the Sicilian port of Messina. Most of the sailors aboard the ships were dead. Those still alive were gravely ill and were covered in mysterious black boils that oozed blood and pus. Over the next 5 years the Black Death killed approximately 25 million people or a third of Europe's population. That is equivalent to killing everyone who lives in the 10 largest cities in the United States in only 5 years. In the 14th century there was no rational explanation for what happened. No one knew what caused the Black Death, how it was transmitted, or how to prevent or treat it. Today we know that plague is caused by *Yersinia pestis* bacteria, is usually transmitted to humans through fleas, and can be successfully treated with antibiotics.

Disease Concepts and Terminology

“From the bitterness of disease man learns the sweetness of health.”

—Catalan proverb

In this chapter you embark on the exciting and challenging study of human disease. This chapter of your journey introduces you to key terms and concepts that you will use throughout the text. We first consider the nature of health and disease.

Health and Disease

We all can recognize a state of **health**. Health is the condition in which the human body performs its vital functions normally. In health the body's various organ systems function optimally and a person can participate fully in his or her life. Health depends on the body maintaining **homeostasis**, relatively stable internal conditions under fluctuating environmental conditions. In homeostasis, the body's organ systems normally maintain temperature, pH, blood composition, and fluid levels within a precise range and correct any fluctuations before they threaten the body's health.

We also can recognize the presence of disease. Employing the concept of homeostasis, we can more precisely describe disease. A significant disturbance in the homeostasis of the body leads to **disease**. Disease is a deviation from normal structure or function in the body that interrupts or modifies the performance of vital functions. For example, the amount of glucose in the blood is tightly regulated to ensure that organs receive an adequate supply of energy. Insulin is a chemical messenger that helps maintain the level of glucose in the blood, increasing or decreasing glucose as the body's needs dictate. If the pancreas were to make no insulin, the amount of glucose in the blood would rise, leading to a number of health problems we associate with the disease diabetes.

Pathology is the study of disease, especially the structural and functional changes associated with disease. The study of disease includes study of its causes, mechanisms, signs and symptoms,

treatments, and prevention. A **pathologist** is a physician who studies and interprets the changes caused by disease. Pathologists act as detectives, examining cells, tissues, organs, and lab test results to find clues about the nature of disease.

Recognizing Disease

A disease can be recognized through its characteristic **signs** and **symptoms**. Signs are evidence of disease observed on physical examination, such as abnormal pulse or respiratory rate, fever, and sweating. Symptoms are indications of disease reported by the patient, such as pain, dizziness, and itching. For example, signs and symptoms of type 1 diabetes mellitus include frequent urination, extreme thirst, excessive hunger, and weight loss. A disease that causes no signs or symptoms is called an asymptomatic disease. An example of an asymptomatic disease is chlamydia, a sexually transmitted infection.

The terms **syndrome** and **disorder** are occasionally used when discussing human disease. A syndrome is an abnormal structure or function characterized by a group of signs and symptoms that usually occur together. Examples of syndromes include acquired immunodeficiency syndrome (AIDS), malabsorption syndrome, and Down syndrome. A disorder is a functional abnormality not necessarily linked to a specific cause or physical abnormality. Examples of disorders include attention-deficit/hyperactivity disorder, premenstrual dysphoric disorder, and hemorrhoids. Disorders might be accompanied by specific signs and symptoms; however, their presence is not required for a condition to be termed a disorder.

Diagnosis of Disease

Doctors identify types of diseases in order to treat them effectively. **Diagnosis** is the process of identifying a disease or disorder. Several types of information are used for diagnosis, including signs and symptoms, which can be quite specific and therefore helpful for diagnosing certain diseases. Signs and symptoms can be ascertained

through physical examination and interviews with a patient or with a patient's family. Frequently the course and history of the signs and symptoms yields important diagnostic information. Similarly, family disease history may give insight into genetic risk for developing certain diseases.

A physical exam includes a number of procedures:

- Inspection refers to a visual examination of the external surface of the body, its movements, and posture for abnormalities or evidence of disease.
- Palpation, feeling the body with fingers or hands, allows examination of the size, consistency, texture, location, and tenderness of an organ or body part.
- Auscultation, listening to the lungs, heart, and intestines, allows evaluation of the frequency, intensity, duration, number, and quality of sounds originating in the body.
- Percussion, producing sounds by tapping on specific areas of the body with fingers, hands, or a small instrument, allows evaluation of the size, consistency, and borders of the body organs, and the presence or absence of fluid in body areas.
- Vital signs (pulse, respiratory rate, blood pressure, temperature) are measures of various physiological statistics in order to assess the most basic body functions. Normal vital signs vary with age, sex, weight, exercise tolerance, and physical condition.

Diagnosis also relies on results of laboratory tests that analyze the composition of urine, blood, throat swabs, stool, sputum, and other patient samples. A biopsy, surgical removal and analysis of tissue samples, yields information about changes at the cellular level. Biopsy can reveal valuable information about tumors.

Other commonly used diagnostic procedures allow physicians to visualize the structure or function of internal organs. These procedures

are discussed in more detail throughout the text. Imaging technologies include:

- Electrocardiography reads the heart's electrical impulses.
- Radiography uses x-rays to visualize internal structures.
- Computed tomography (CT) scan uses computers and x-rays to create three-dimensional images of internal structures.
- Magnetic resonance imaging (MRI) analyzes tissue responses to a strong magnetic field to create images of internal structures.
- Ultrasound analyzes the interaction of low-frequency sound waves with tissues to create moving images of internal organs.
- Nuclear medicine uses radioactive materials to create contrast in the body and help form images of the structure and function of organs.

The Course of a Disease

The physician, having made a diagnosis, may state the **prognosis** of the disease, or its predicted course and outcome. The prognosis may state the chances for complete recovery, predict the permanent loss of function, or give probability of survival.

The course of a disease varies. An **acute** disease has a sudden onset and short duration. Influenza, measles, and the common cold are examples of acute infections. Diseases that will end in death are called **terminal**. A **chronic** disease has a slower, less severe onset and a long duration of months or years. Examples of chronic diseases include heart disease, cancer, stroke, diabetes, and arthritis.

Chronic diseases are a significant cause of death, accounting for 7 in 10 deaths in the United States, and 6 in 10 deaths worldwide each year (Table 1-1 ► and Table 1-2 ►). The leading causes of death differ among countries and are closely tied to a country's income level and economic development. Chronic diseases are among the leading causes of death in wealthy Western countries. Infectious diseases are more important causes of death in low income countries

TABLE 1–1 Ten Leading Causes of Death in the United States, 2010

Disease	Number of deaths
Diseases of the heart	597,689
Malignant neoplasms (cancer)	574,743
Chronic lower respiratory diseases	138,080
Cerebrovascular diseases (stroke)	129,476
Accidents	120,859
Alzheimer's disease	83,494
Diabetes mellitus	69,071
Nephritis, nephrotic syndrome, and nephrosis	50,476
Influenza/pneumonia	50,097
Intentional self-harm (suicide)	38,364
<i>Source:</i> www.cdc.gov/nchs/data_access/Vitalstatsonline.htm.	

TABLE 1–2 Ten Leading Causes of Death in the World, 2011

Disease	Number of deaths
Ischemic heart disease	7,000,000
Stroke and other cerebrovascular disease	6,200,000
Lower respiratory infections	3,200,000
Chronic obstructive pulmonary disease	3,000,000
Diarrheal disease	1,900,000
HIV/AIDS	1,600,000
Trachea, bronchus, lung cancers	1,500,000
Tuberculosis	1,400,000
Diabetes	1,300,000
Road traffic accidents	1,200,000
<i>Source:</i> World Health Organization, Fact Sheet No. 310, updated July 2013	

(Table 1–3 ► and Table 1–4 ►). It is predicted that the four leading causes of death in the world in 2030 will be heart disease, stroke, chronic obstructive pulmonary disease (COPD), and lower respiratory infections (mainly pneumonia).

Some diseases enter a period of **remission** during which its signs and symptoms subside or disappear. However, a remission is not considered a cure. A remission may last days, months, or years, after which the disease can recur. At times, signs and symptoms may grow more severe, a period of **exacerbation**. Certain diseases (leukemia and ulcerative colitis, for example) are characterized by periods of remission, recurrence, and sometimes exacerbation. A **relapse** describes the return of a disease weeks or months after its apparent cure.

A **complication** is a related disease or other abnormal state that develops in a person already suffering from a disease. For example, a person confined to bed with a serious fracture may develop pneumonia as a complication of the inactivity. The complication may interfere with recovery from the original disease. Anemia is a common

complication of leukemia, cancer, and chronic kidney disease. Anemia makes it harder to recover from those diseases. The aftermath of a particular disease is called the **sequela**, or sequel. A sequela of rheumatic fever is permanent damage to the heart and a sequel of polio is paralysis. Sterility may be a sequela of pelvic inflammatory disease and sexually transmitted infections.

Describing the Occurrence of Disease

Public health agencies gather data about how, when, and where diseases occur. The data give public health officials and physicians an idea of how serious a disease is and thus help direct resources toward prevention and treatment. The number of deaths caused by a disease is important to monitor. **Mortality** is the number of deaths that occur among people with a certain disease.

Even if a disease causes very few deaths, it is still important to monitor the presence of that disease. Illness causes lost days of work and school, leads to disability, incurs medical expenses, and can have a big impact on the economy. Thus,

TABLE 1–3 Ten Leading Causes of Death in Low-Income Countries, 2008

Disease	Number of deaths
Lower respiratory infections	1,050,000
Diarrhea disease	760,000
HIV/AIDS	720,000
Ischemic heart disease	570,000
Malaria	480,000
Stroke and other cerebrovascular disease	450,000
Tuberculosis	400,000
Prematurity and low birth weight	300,000
Birth asphyxia and birth trauma	270,000
Neonatal infections	240,000
<i>Source: World Health Organization, Fact Sheet No. 310, updated June 2011</i>	

officials monitor **morbidity**, the **incidence** of disease. Morbidity is the number of cases of a disease in a population. For example, in 2009 there were an estimated 48,100 new human immunodeficiency virus (HIV) infections in the United States. By monitoring the incidence of HIV infections, researchers and officials can track changes in the occurrence of HIV and respond with appropriate interventions to control it.

Prevalence is the percentage of a population that is affected with a particular disease at a given time. For example, at the end of 2009 an estimated 1,148,200 persons aged 13 and older were living with HIV infection in the United States. Prevalence data allow the determination of the impact and significance of a disease for a given population and these data are used to direct health care resources and research. Prevalence data also help doctors see the significance of certain diseases for certain demographics. In this way we learn that cancer, cardiovascular disease, and diabetes are more prevalent in older adults than in adolescents.

TABLE 1–4 Ten Leading Causes of Death in High-Income Countries, 2008

Disease	Number of deaths
Ischemic heart disease	1,420,000
Stroke and other cerebrovascular disease	790,000
Trachea, bronchus, lung cancers	540,000
Alzheimer's and other dementias	370,000
Lower respiratory infections	350,000
Chronic obstructive pulmonary disease	320,000
Colon and rectum cancers	300,000
Diabetes mellitus	240,000
Hypertensive heart disease	210,000
Breast cancer	170,000
<i>Source: World Health Organization, Fact Sheet No. 310, updated June 2011</i>	

Epidemiology is the study of the occurrence, transmission, distribution, and control of disease. Epidemiologists use prevalence and incidence data and information about the geographic distribution of disease to develop methods to prevent and control diseases. The Centers for Disease Control and Prevention (CDC; www.cdc.gov) in Atlanta, Georgia, is the chief epidemiologic institution in the United States. The World Health Organization (WHO; www.who.int) in Geneva, Switzerland, acts as a coordinating authority on international public health.

Causes of Disease

An important aspect of any disease is its **etiology**, or cause. A related concept, **pathogenesis**, describes how the cause of a disease leads to anatomical and physiological changes in the body that ultimately result in the disease. If the cause of a disease is not known, it is said to be **idiopathic**. You will learn about several idiopathic diseases as you read this text.

TABLE 1–5 Major Categories of Diseases

Category	Disease
Hereditary diseases	Hemophilia, sickle cell anemia, cystic fibrosis
Congenital diseases	Tetralogy of Fallot (heart abnormality)
Degenerative diseases	Arteriosclerosis, osteoarthritis, Alzheimer's disease
Inflammation/autoimmunity/allergy	Asthma, systemic lupus erythematosus, hay fever
Infectious diseases	Tuberculosis, influenza, syphilis
Neoplastic diseases	Lung cancer, malignant melanoma, breast cancer
Metabolic diseases	Diabetes, hypothyroidism, gigantism
Trauma	Burns, frostbite, bone fractures
Nutritional-imbalance diseases	Iron-deficiency anemia, scurvy, obesity

Causes of disease are often divided into several categories (Table 1–5 ►). Some diseases seem to have a single cause, while many diseases actually have several causes. The chief causes of disease are:

- **Hereditary.** Abnormality in an individual's genes or chromosomes.
- **Congenital.** Exist at or date from birth; can be acquired through heredity or acquired during development in the uterus.
- **Degenerative.** Function or structure of the affected tissues or organs progressively deteriorates over time.
- **Inflammatory, autoimmune, and allergic.** Result of abnormal immune function; infectious diseases are caused by pathogens such as bacteria and viruses.
- **Neoplastic.** Result from abnormal growth that leads to the formation of tumors.
- **Metabolic.** Disruption of normal metabolism, the process of converting food to energy on a cellular level.
- **Traumatic.** Physical or chemical injury.
- **Nutritional.** Over- or underconsumption of nutrients.

Risk Factors

Risk factors increase a person's chance of developing a disease. Note that a risk factor is not equivalent to etiology. While an individual with

risk factors for a certain disease has an increased chance of developing that disease, that person will not necessarily acquire the disease. However, by eliminating known risk factors for a disease, a person may reduce the chance of developing that disease.

Risk factors may be environmental, chemical, physiological, psychological, or genetic. A well-known risk factor for lung cancer is cigarette smoking. The development of coronary artery disease has multiple well-established risk factors, such as high cholesterol and lipids, high blood pressure, diabetes, obesity, and physical inactivity. Four modifiable risk factors (lack of physical activity, poor nutrition, tobacco use, and excessive alcohol consumption) are responsible for much of the illness, disability, and premature death related to chronic diseases.

Health Promotion and Disease Prevention

"The function of protecting and developing health must rank even above that of restoring it when it is impaired."

—Hippocrates

The United States spends significantly more on health care than any other nation, more than twice the average of other developed countries. More than 75% of U.S. health care dollars go

Prevention PLUS!

Four Modifiable Risk Factors for Chronic Disease

1. Poor nutrition

Before you eat, think about what goes on your plate. Vegetables, fruits, whole grains, low-fat dairy products, and lean protein contain the nutrients you need without too many calories.

To build a healthy plate:

- Make half your plate fruits and vegetables.
- Switch to skim or 1% milk.
- Make at least half your grains whole.
- Vary your protein choices.
- Cut back on foods high in solid fats, added sugars, and salt.

2. Lack of physical activity

Be physically active. Adults should do strength and flexibility training at least two times per week and engage in at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity aerobic activity or a combination of both each week.

3. Tobacco use

Smoking is the leading cause of preventable death in the United States. Mark Twain said, "Quitting smoking is easy. I've done it a thousand times." It's hard to quit smoking, but you can do it. There are resources

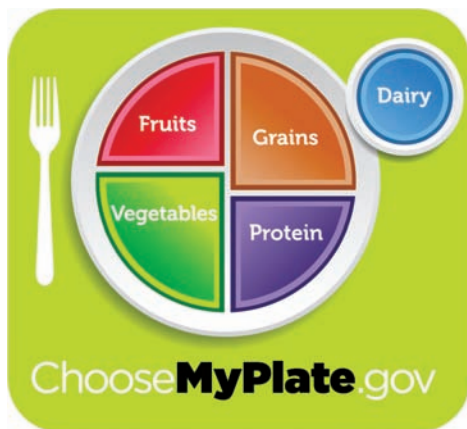
available to help you quit using tobacco (e.g., www.smokefree.gov).

4. Excessive alcohol consumption

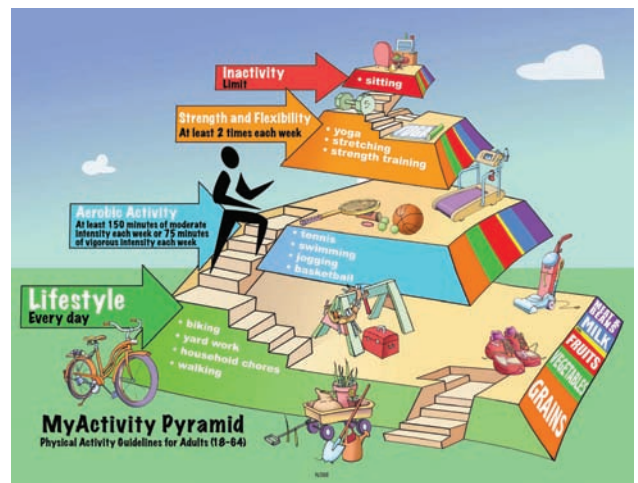
If you choose to consume alcohol, The U.S. Department of Agriculture *2010 Dietary Guidelines for Americans* recommends moderate alcohol consumption, defined as up to one drink per day for women and up to two drinks per day for men. This definition is referring to the amount consumed on any single day and is not intended as an average over several days.

Think Critically

1. What are the four modifiable risk factors for chronic disease?
2. Moderate alcohol consumption is defined as how many drinks per day for men? For women?
3. How many times per week should you engage in strength and flexibility training?
4. How many minutes of vigorous-intensity aerobic activity does an adult need to do per week?
5. How much of your healthy plate should be fruits and vegetables?



Source: www.choosemyplate.gov/print-materials-ordering/graphic-resources.html



Source: University of Missouri Extension

to treatment of chronic diseases instead of to prevention, even though investing in prevention would yield a significant reduction in disease and health care costs. Health care based on prevention seeks to promote healthy living, detect chronic diseases early, and manage chronic diseases and related complications. Health promotion and preventive medicine are highlighted further in Part II of this text. Here we preview a few simple steps that can decrease the burden of disease and promote long, healthy lives.

- Be physically active. More than a third of U.S. adults do not meet minimum recommendations for aerobic physical activity as recommended by the U.S. Department of Health and Human Services *2008 Physical Activity Guidelines for Americans*. Regular physical activity decreases the risk for developing depression, type 2 diabetes, heart disease, high blood pressure, obesity, stroke, and some kinds of cancer.
- Eat wisely. Twenty-two percent of U.S. high school students eat five or more servings of fruits and vegetables per day. More than 60% of U.S. children and adolescents consume more than the *2010 Dietary Guidelines for Americans* recommends for saturated fat. Good nutrition can lower the risk for heart disease, stroke, some cancers, diabetes, and osteoporosis.
- Maintain a healthy weight. Obesity is major risk factor for heart disease, stroke, diabetes, and some types of cancer. During the past 20 years, there has been a dramatic increase in obesity in the United States. About a third of U.S. adults are obese and approximately 17% of children and adolescents age 2–19 years are obese. Losing 5–10% of your body weight can lower blood pressure, reduce LDL cholesterol, improve glucose tolerance, and lower your risk for heart disease.
- Be tobacco free. Tobacco use is the single most avoidable cause of disease, disability, and death in the United States and is responsible for almost 1 in 10 adult deaths worldwide. Tobacco use causes some cancers, heart disease, heart attack, stroke, and chronic obstructive pulmonary disease.

Within 2 weeks to 3 months after quitting, heart attack risk begins to drop and lung function begins to improve. One year after quitting, excess risk for heart disease is reduced by half, and 10 years after quitting the lung cancer death rate is about half that of a current smoker. Fifteen years after quitting, an ex-smoker's risk for heart disease is about the same as that of a lifelong nonsmoker.

- Limit alcohol. Excessive alcohol use is associated with a wide range of health problems including cirrhosis, pancreatitis, high blood pressure, and some cancers.
- Get recommended screening tests and immunizations. Refer to the following websites from the U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, to see which preventative services are recommended for you:

Men stay healthy at any age: www.ahrq.gov/ppip/healthymen.htm

Women stay healthy at any age: www.ahrq.gov/ppip/healthywom.htm

- Manage stress. Stress is a normal psychological and physical reaction to our demanding lives. Excess stress can trigger or worsen depression, heart disease, and some cancers and can speed the

Healthy Aging

Preventing Falls

Each year, one in every three adults age 65 or older falls and 2 million are treated in emergency departments for fall-related injuries. To prevent falls:

- Be physically active. Lack of exercise can lead to weak muscles and can increase the risk of falls.
- Be mindful of medications. Some medications have side effects like dizziness or drowsiness.
- Keep your vision sharp. Poor vision can make it harder to get around safely.
- Eliminate hazards at home. Half of falls happen at home. Check your home for potential fall hazards.

progression of HIV/AIDS. The good news is that stress can be managed. Seek help and support from family, friends, counselors, and doctors. Relaxation techniques such as meditation, tai chi, and yoga can help reduce stress.

Treatment of Disease

Treatment aims to cure a disease or reduce the severity of its signs and symptoms. Not all diseases are curable, and in some cases, the causes are unknown. Thus some treatments are described as symptomatic, designed to relieve and manage the symptoms of the disease without addressing the cause. No cure exists for the common cold or hay fever, but medical treatment can effectively provide relief by mitigating the effects of the symptoms. The goal of palliative treatment is to provide comfort and relieve pain. People with terminal cancer may receive palliative treatments.

Treatment includes medical (pharmacologic) procedures, which use specific drugs to cure or relieve signs and symptoms. For example, antibiotics kill the bacteria that cause pneumonia and analgesics control the pain associated with cancer. Other diseases require surgery to correct anatomical and physiological abnormalities. Surgery can be used to remove a tumor or to repair a defect in the intestines. Psychiatric and psychological treatments are used for mental disorders such as anxiety or depression. In some cases, effective treatment requires the use of several procedures simultaneously.

Readers will apply disease terms and concepts learned in this chapter throughout their study of human diseases.

Resources

- 2008 Physical Activity Guidelines for Americans: www.health.gov/paguidelines/
- 2010 Dietary Guidelines for Americans: <http://health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf>
- Centers for Disease Control and Prevention. *Chronic Disease Prevention and Health Promotion*. www.cdc.gov/chronicdisease/overview/index.htm
- Centers for Disease Control and Prevention. *HIV/AIDS Basic Statistics*. www.cdc.gov/hiv/topics/surveillance/basic.htm#hivest
- Centers for Disease Control and Prevention. *The Power of Prevention: Chronic Disease . . . The Public Health Challenge of the 21st Century*. www.cdc.gov/chronicdisease/pdf/2009-Power-of-Prevention.pdf
- Centers for Disease Control and Prevention: www.cdc.gov
- Choose my plate: www.choosemyplate.gov
- Kochanek, KD, et al. Deaths: Preliminary Data for 2009. *National Vital Statistics Report*, Vol. 59, No. 4, March 16, 2011. www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_04.pdf
- 75 Years of Mortality in the United States, 1935–2010. NCHS Data Brief. No. 88, March 2012. www.cdc.gov/nchs/data/databriefs/db88.htm
- Smokefree.gov: www.smokefree.gov
- United States Department of Health and Human Services: www.dhhs.gov
- World Health Organization. *The Top 10 Leading Causes of Death*. Fact Sheet No. 310, updated June 2011. www.who.int/mediacentre/factsheets/fs310/en/index.html
- World Health Organization. *World Health Statistics 2008*. www.who.int/whosis/whostat/EN_WHS08_Full.pdf
- World Health Organization: www.who.int

Promote Your Health

Yoga to Reduce Stress

A number of studies have shown that yoga can help reduce stress and anxiety. Hatha yoga, in particular, may be a good choice for stress management. The core components of hatha yoga and most general yoga classes are:

Poses. Yoga poses, also called *postures*, are a series of movements designed to increase strength and flexibility.

Poses range from lying on the floor while completely relaxed to difficult postures that may have you stretching your physical limits.

Breathing. Controlling your breathing is an important part of yoga. In yoga, breath signifies your vital energy. Yoga teaches that controlling your breathing can help you control your body and quiet your mind.

Interactive Exercises

Cases for Critical Thinking

1. Some athletes may develop abnormally high red blood cell counts. Why? In the athlete's case, is this a sign of disease?
 2. A patient reports to her physician that she feels weak and dizzy. Is this enough information to make a diagnosis? What other sources of information can her physician consult?
 3. Consult Table 1–1. How can this information be used to direct health care research and resources? What is the significance of the information about accidents?
 4. Chronic diseases and their major risk factors place huge economic demands on our nation.
- For example, from 1987 to 2001 increases in obesity prevalence alone accounted for 12% of the growth in health care spending. What factors may have contributed to this increase in obesity in the United States? What is being done or what could be done to reverse the trend?
5. Consult Tables 1–3 and 1–4. In high-income countries what are the major causes of death? In low-income countries what are the major causes of death? How can this information be used to direct health care research and resources?

Multiple Choice

1. A skin rash is an example of a _____.
a. sign
b. symptom
c. laboratory result
d. syndrome
2. A(n) _____ disease has a sudden onset and short course.
a. acute
b. terminal
c. chronic
d. idiopathic
3. The cause of a disease is known as its _____.
a. pathogenesis
b. complication
c. sequela
d. etiology
4. The condition in which the human body performs its vital functions normally is known as _____.
a. health
b. disease
c. disorder
d. homeostasis
5. Signs and symptoms grow more severe in a period known as _____.
a. remission
b. exacerbation
c. relapse
d. complication

True or False

- _____ 1. Homeostasis refers to the process of identifying a disease from its signs and symptoms.
- _____ 2. Mortality refers to the number of deaths caused by a disease.
- _____ 3. Symptoms are objective evidence of a disease.
- _____ 4. Signs may be perceived by the physician.
- _____ 5. Remission and relapse may characterize a chronic disease.

Fill-Ins

- 1. The predicted outcome of a disease is its _____.
- 2. Diseases with a rapid onset and resolution are called _____ diseases.
- 3. If the cause of a disease is not known, it is said to be _____.
- 4. Return of symptoms after their apparent cessation is _____.
- 5. The signs and symptoms of a chronic disease at times subside during a period known as _____.

Chapter 2

Immunity and Disease

Learning Objectives

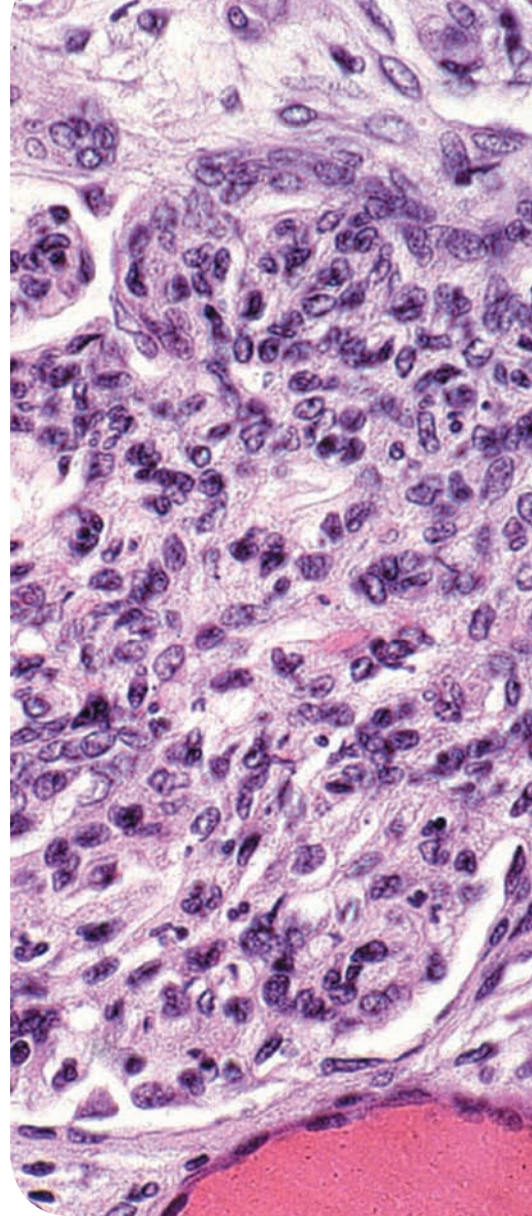
After studying this chapter, you should be able to

- Describe the function of the immune system
- Explain the nonspecific immune response to infection
- Explain the humoral immune response and the role of antibodies in immunity
- Describe the cell-mediated immune response and the role of T cells in immunity
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention of lupus, scleroderma, and Sjögren's syndrome
- Describe allergy and hypersensitivity
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention of HIV and AIDS
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention of Hodgkin's and non-Hodgkin's lymphoma

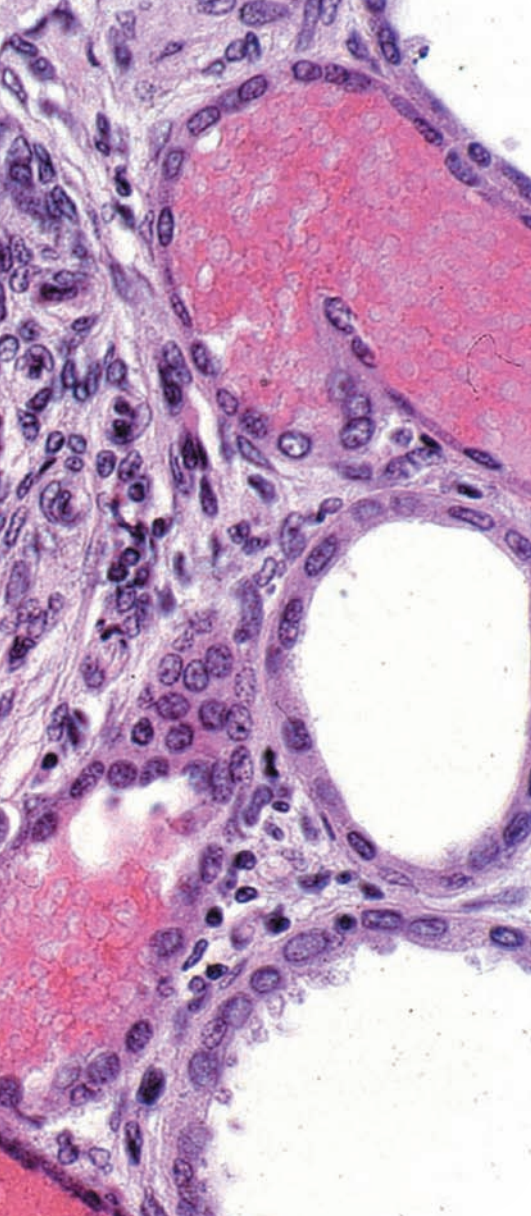
Fact or Fiction?

Human immunodeficiency virus (HIV) can be transmitted from casual contact (shaking hands, hugging, sharing a toilet, drinking from the same glass, kissing) with an HIV-infected person.

Fiction: HIV is transmitted by specific body fluids from an HIV-infected person (blood, semen, vaginal secretions, and breast milk). HIV is not transmitted from casual contact.



In these renal glomeruli, there is proliferation of cells representing proliferative glomerulonephritis. (Courtesy of the National Toxicology Program)



Disease Chronicle

Inflammation

Throughout history, humans undoubtedly have observed the inflammatory response even if they understood little of its causes or treatment. Around 1500 B.C., Egyptians used dried myrtle leaves to relieve back pain. In 200 B.C., Greek physician Hippocrates prescribed willow bark leaves to relieve fever and pain. One of the early systematic descriptions of inflammation came from Roman physician Aulus Cornelius Celsus (25 B.C.–50 A.D.), who recorded its cardinal signs: heat, redness, swelling, and pain. Today, the active ingredient in aspirin, acetylsalicylic acid, is derived from a related anti-inflammatory chemical (salicylic acid) found in myrtle leaves and willow tree bark.

Immunity

Every day our bodies encounter bacteria, viruses, fungi, and other foreign substances, and yet we stay healthy most of the time. **Immunity** is the body's ability to resist infectious disease. The immune system protects the body by distinguishing "self" from "nonself." That is, the immune system coexists peacefully with the body's own cells, which display distinctive "self" molecules. However, the immune system responds to cells and substances that are not from the body. An **antigen** is any foreign substance that, when introduced into the body, is recognized as "nonself" and activates the immune system.

Resistance to infection relies on two types of immunity, **nonspecific immunity** and **specific immunity** (Figure 2-1 ►). Together, nonspecific immunity and specific immunity comprise the immune system: organs and white blood cells dispersed around the body that are responsible for providing immunity. Nonspecific immunity is always prepared to defend the body against disease. Specific immunity, however, must be primed by an initial exposure to an antigen before it can protect the body against disease caused by that particular antigen.

Nonspecific Immunity

Nonspecific immunity, also known as innate immunity, is present at birth and provides immediate, short-term protection against any antigen. Nonspecific immunity prevents entry and spread of disease-causing microorganisms (**pathogens**) by means that include physical barriers such as intact skin and mucous membranes as well as cellular and chemical defenses.

Several physical barriers protect the body from pathogens. Intact skin prevents entry of pathogens and other harmful substances into the body. Skin also produces chemical barriers to infection. Secretions such as tears, saliva, sweat, and sebum contain chemicals that destroy foreign invaders. Mucous membranes line all body passages open to the exterior and produce mucus, which traps foreign material and forms a barrier to invasion. Microscopic cilia hairs that line the respiratory tract sweep out debris and pathogens trapped in mucus.

Pathogens that make it past the skin and mucous membranes must face additional defenses. Leukocytes (white blood cells) such as macrophages and neutrophils can engulf and destroy pathogens, a process called phagocytosis. These leukocytes are known as **phagocytes**.

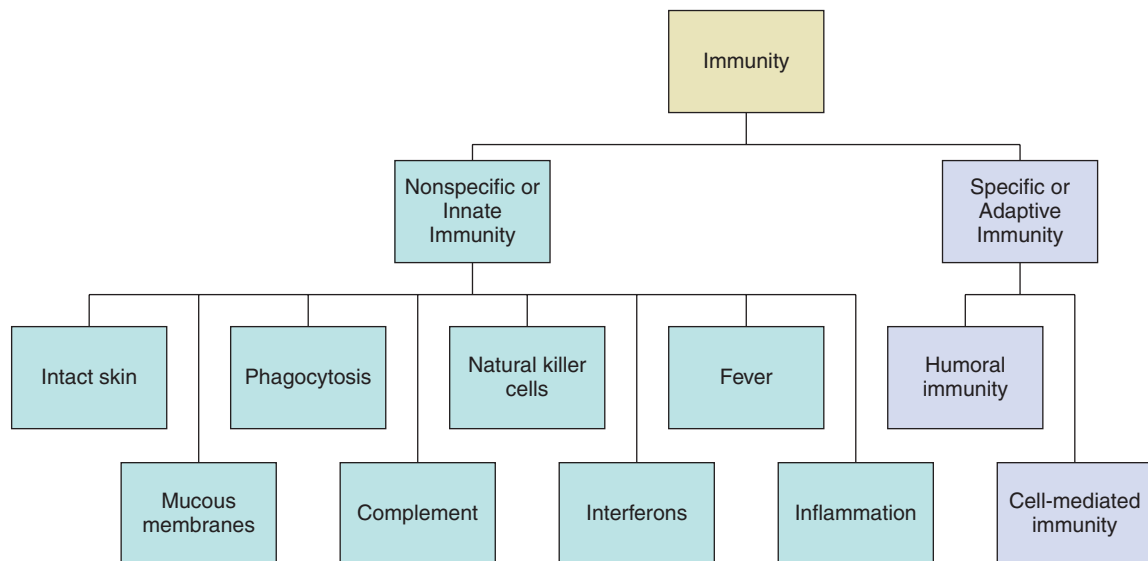


Figure 2-1 ► Types of immunity.

Macrophages reside below the epidermis and mucous membranes and in many tissues. Neutrophils spend most of their time in blood but leave the blood and enter tissues at sites of injury and infection.

Complement is a group of plasma proteins that assist in the destruction of foreign cells. These proteins circulate in an inactive state, but when complement becomes attached to bacteria cells it becomes active. Activation of complement results in a cascade of biochemical reactions leading to lysis (rupturing the cell membrane) of bacteria. Activated complement attracts phagocytes to the area and enhances the inflammatory response. Complement is part of nonspecific immunity, but it helps both nonspecific and specific immunity.

Natural killer cells are a type of leukocyte that recognize and eliminate virus-infected cells and cancer cells. Natural killer cells are not phagocytic. Instead, they secrete chemicals that cause pores to form in the membrane of a target cell, leading to its death.

Interferons are antiviral proteins produced by some animal cells after viral infection. Interferons stimulate nearby uninfected cells to resist viral infection. Interferons also increase the activity of macrophages and natural killer cells. Interferons have been used to treat infections (hepatitis B and C) and some cancers (melanoma and Kaposi's sarcoma).

"Give me a fever, and I can cure any illness"
—Hippocrates

Fever, or an abnormally high body temperature, is a systemic response to an infection. Benefits of fever include slowing the growth rate of some pathogens, increasing the effect of interferons, enhancing phagocytosis, stimulating antibody production, and accelerating tissue repair. Because of its benefits, fever should not always be eliminated; however, fever should be monitored closely. Very high fevers can cause dehydration, nausea, disorientation, hallucinations, seizures, and convulsions.

Inflammation, or the inflammatory response, can be triggered by infection, trauma, intense heat, and chemicals. Inflammation prevents the spread of pathogens, disposes of cell debris and pathogens, and aids in repair of damaged tissue.

After an injury, the damaged cells release potent chemical signals including histamines and kinins. These chemicals cause blood vessels in the area to dilate and become more permeable, which causes the cardinal signs and symptoms of inflammation: redness, heat, swelling, and pain. Phagocytes are also attracted to the area. Clotting proteins are activated and begin to wall off the damaged area. As the inflammatory response continues, debris and dead and dying cells may accumulate, forming pus.

Specific Immunity

Specific immunity, also known as adaptive immunity, responds to antigens of specific pathogens. Once the adaptive immune system encounters and responds to an antigen, the body is able to respond quickly to future exposures to the same antigen. This permits the body to protect itself from infection during subsequent exposures to that pathogen. This ability to remember past encounters with pathogens is called immunologic memory.

Adaptive immunity includes two separate but overlapping arms called **humoral immunity** and **cell-mediated immunity**. Humoral immunity is due to the action of antibodies, which are proteins produced by white blood cells called B lymphocytes (or **B cells**). Antibodies (which are also called immunoglobulins) provide a defense against extracellular antigens such as bacterial toxins and bacterial cells.

Cell-mediated immunity provides a defense against viruses, abnormal cells, and other intracellular pathogens, and it is the arm of the immune system responsible for rejecting tissue grafts and organ transplants. T lymphocytes (or **T cells**) are responsible for cell-mediated immunity.

T cells and B cells, like all blood cells, originate in the red bone marrow. Immature T cells leave the bone marrow and enter the thymus where they develop the ability to react with a unique antigen. B cells develop their ability to recognize unique antigens in the red bone marrow. Once T and B cells know how to recognize antigens, they leave the thymus and bone marrow and travel to the lymph nodes and spleen where they wait to be activated by their antigen.

The first exposure to an antigen triggers humoral immunity. Extracellular antigens directly activate a B cell by binding to a receptor on the surface of the B cell. The activated B cell divides and develops into plasma cells and long-lived memory B cells. Plasma cells live about 4 or 5 days and secrete antibodies. Antibodies (immunoglobulins) bind to antigens, making them easier targets for phagocytes and complement. There are several types of immunoglobulins (Ig), each with specialized functions. See Table 2-1 ► for a summary of Ig functions.

Memory B cells are responsible for a more potent and rapid antibody response during subsequent exposures to the same antigen. This secondary response to the antigen produces antibodies faster and in larger quantities, and lasts longer than the initial response (Figure 2-2 ►).

In addition to providing humoral immunity, as just described, the first exposure to an antigen also triggers cell-mediated immunity. A **helper T cell** (also called a CD4 cell) becomes activated by an antigen that was engulfed and digested by a phagocyte and presented to the helper T cell. The activated helper T cell divides, producing additional identical helper T cells (clones) and long-lived memory T cells. The helper T cell clones stimulate antibody production by plasma cells, increase phagocytosis, and stimulate cytotoxic

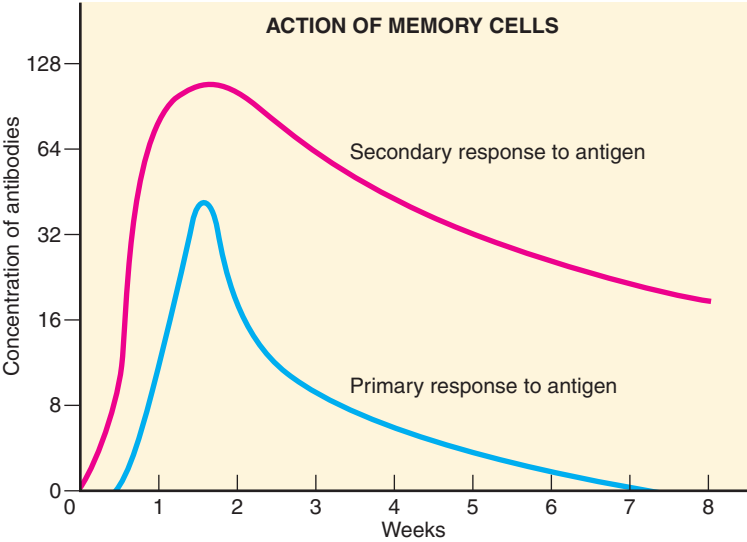


Figure 2-2 ► Secondary response begins more rapidly after exposure to antigen, produces more antibodies, and lasts for a longer time than initial exposure.

T cells and natural killer cells. Memory T cells can rapidly mobilize should the same antigen be encountered again. **Cytotoxic T cells** (also called CD8 cells) are activated by antigens displayed on infected cells, abnormal cells, and transplanted organs and tissues. In response to these antigens, an activated cytotoxic T cell divides and produces clones and memory T cells. Cytotoxic T cells kill infected and abnormal cells and also kill transplanted organs and tissues. See Table 2-2 ► for a summary of B and T cells.

TABLE 2-1 Immunoglobulin Function	
Immunoglobulin	Function
IgG	Principal component of the primary and secondary response to an antigen. Crosses the placenta and protects the fetus. Activates complement.
IgM	First antibody produced in the primary response to the antigen. Activates complement.
IgA	Protects mucosal surfaces by interfering with the ability of pathogens to adhere to cells.
IgE	Stimulates release of histamine and other chemicals that mediate inflammation and allergic responses.
IgD	Activates B cells.

TABLE 2–2 B and T Cells

	B Cells	T Cells
Type of immunity	Humoral	Cell-mediated
Antibody secretion	Yes	No
Primary target	Extracellular pathogens	Intracellular pathogens and cancer cells
Site of origin	Red bone marrow	Red bone marrow
Where antigen recognition is developed	Red bone marrow	Thymus
Memory cell formation	Yes	Yes

Age and the Immune System

Immune system function declines with advancing age, leading to greater risk for infection and decreased ability to fight infectious disease. As humans age, the thymus atrophies, causing a sharp decrease in the number and type of T cells produced. There are fewer T cells capable of responding to new antigens. Therefore, when older people encounter a new antigen, the body is less able to recognize and defend against it. It takes longer for macrophages to destroy bacteria, viruses, cancer cells, and other antigens. The amount of antibody produced in response to an antigen and an antibody's ability to attach to an antigen are reduced. Because of reduced antibody production, vaccines are less likely to produce immunity in older people. While vaccines do not work as well in older adults, vaccinations for diseases such as influenza, pneumonia, hepatitis B, tuberculosis, diphtheria, and tetanus have been found to reduce mortality in older adults and are still worthwhile.

Healthy Aging

Seasonal Influenza

Older adults are particularly susceptible to seasonal influenza. Most hospitalizations and deaths from the seasonal flu occur in people over the age of 65 who have underlying medical conditions. Older adults should get a yearly flu vaccine.

Diagnostic Testing

The specificity of antibodies for antigens has been applied to the development of diagnostic laboratory tests that are used to detect and identify infectious diseases. These tests detect the presence of antibodies to a specific pathogen or they detect the presence of antigen from specific pathogen.

- Agglutination reactions of antigen and antibody detect bacterial (streptococci that causes strep throat) and viral (mononucleosis, measles, mumps, influenza) diseases and are used in blood typing.
- Enzyme immunoassay (EIA) uses an enzyme to label either the antibody or antigen. One of the most widely used EIA methods for detection of infectious diseases is the enzyme-linked immunosorbent assay (ELISA).
- Western blot detects the presence of antibodies in patient serum.
- Fluorescent antibody techniques use an antibody labeled with a fluorescent molecule to detect its antigen and are used to detect a wide variety of microorganisms.
- Flow cytometry identifies and counts cells that have a particular antigen. An interesting modification of a flow cytometer is the fluorescent-activated cell sorter (FACS). FACS is used to count helper T cells to follow the progression of HIV/AIDS.
- C-reactive protein and erythrocyte sedimentation tests measure general levels of inflammation in the body.

Autoimmunity

The immune system normally distinguishes between the individual's own tissues and pathogens. The lack of response to the body's own cells is known as tolerance. When tolerance fails, an autoimmune disease may result. **Autoimmunity** occurs when individuals develop antibodies called **autoantibodies** to their own tissues or self antigens. Almost all patients with autoimmunity have some autoantibodies present in their serum. It is not known whether the autoantibodies play an important role in the disease or are a secondary result of the tissue damage that has been caused by the disease process itself. Autoimmune patients also have autoreactive T cells.

Autoimmunity has no known cause, so it cannot be prevented. Early diagnosis and treatment of autoimmune diseases may prevent serious complications and greatly improve the patient's quality of life. Several autoimmune diseases are described elsewhere in the text. Three autoimmune diseases are discussed in this chapter: lupus, scleroderma, and Sjögren's syndrome. They affect many different parts of the body and exemplify the severe symptoms and the disability associated with autoimmune disease.

Lupus

Lupus is a chronic autoimmune disease that can affect various parts of the body, including the skin, joints, heart, lungs, blood, kidneys, and brain. The Lupus Foundation of America estimates that 1.5 million Americans, and at least 5 million people worldwide, have a form of lupus. Ninety percent of lupus patients are women, and diagnosis usually occurs between the ages of 15 and 44.

There are four types of lupus: systemic, cutaneous, drug-induced, and neonatal. Seventy percent of people with lupus have the systemic form, called systemic lupus erythematosus (SLE). In SLE many body systems can be involved. About half of SLE patients develop severe disease of the heart, lungs, kidneys, or brain. Common signs and symptoms of SLE include fatigue, arthritis, fever, butterfly rash across cheeks and nose, photosensitivity, and mouth or nose ulcers. The fingers can turn white and/or blue when cold (called secondary Raynaud's phenomenon). Figure 2-3 ► is a photo of



Figure 2-3 ► Raynaud's phenomenon. (Wellcome Image Library/Custom Medical Stock Photo. All rights reserved.)

a patient's hand showing secondary Raynaud's phenomenon.

Cutaneous or discoid lupus affects only the skin and accounts for approximately 10% of all lupus cases. Although there are many types of rashes and lesions caused by cutaneous lupus, the most common rash is raised, scaly, and red, but not itchy. It is commonly known as a discoid rash because the areas of rash are circular. Cutaneous lupus patients may have a butterfly rash across the cheeks and nose. Figure 2-4 ► shows a butterfly lupus rash and a discoid lupus rash. Other rashes or lesions may appear on the face, neck, scalp, mouth, nose, or vagina. Approximately 10% of patients with cutaneous lupus will develop SLE.

Drug-induced lupus erythematosus (DILE) can be brought on by more than 70 different prescription drugs and accounts for about 10% of all lupus cases. The signs and symptoms of DILE are similar to those of SLE; however, DILE rarely affects organs. The medications known to cause drug-induced lupus include hydralazine (used to treat high blood pressure) and procainamide and quinidine (used to treat irregular heart rhythm). Certain drugs entail a high risk, leading to DILE in 5–20% of people who use the drug for 1–2 years. The risk of developing DILE is less than 1% for most other drugs. Signs and symptoms disappear within days to months after discontinuing the drug.

Neonatal lupus is a rare condition acquired from maternal autoantibodies that affect the skin, heart, and blood of the fetus and newborn.



A



B

Figure 2-4 ► (A) Butterfly-shaped lupus rash. *Lupus* is the Latin word for wolf; the face rash was thought to look like the face markings of a wolf (Science Photo Library). (B) Discoid lupus rash (Michael English, MD).

It is characterized by a rash that appears within several weeks of life and persists about 6 months before disappearing.

The etiology of lupus is idiopathic, but environmental and genetic factors may play a role. Some environmental factors that may trigger the disease include infections, sulfa antibiotics and penicillin, ultraviolet light, stress, certain drugs, and hormones. Genetics plays a role in lupus; 20% of lupus patients have a parent or a sibling with lupus. Five percent of children develop lupus if their mother has lupus. Signs and symptoms grow severe before menstrual periods or during pregnancy, which suggests that estrogen may in some way influence the progression of lupus.

Because lupus signs and symptoms mimic those of other illnesses, are sometimes vague, and may come and go, lupus can be difficult to diagnose. Physicians frequently use the 1997 update of the 1982 revised criteria for classification of SLE to aid in SLE diagnosis. Diagnosis begins with a thorough medical history and physical exam. No single test will confirm the diagnosis of lupus. A complete blood count, urinalysis, autoantibody testing, measurement of general levels of inflammation, and biopsy may be performed.

Lupus tends to be chronic and relapsing, often with symptom-free remissions that can last for years. Lupus remains incurable, and its management can be challenging. Lupus patients should limit exposure to sunlight, never

use tobacco, prevent fatigue and stress, eat a healthful diet, exercise, and take care of fevers over 100°F promptly. Although lupus cannot be prevented, several medications treat and control lupus: nonsteroidal anti-inflammatory drugs (NSAIDs), steroidal anti-inflammatory drugs (corticosteroids), antimalarial medications, immunosuppressive drugs, and monoclonal antibodies to inhibit autoantibody and antibody production.

Most lupus patients live a normal lifespan; however, between 10 and 15% of lupus patients die prematurely as a result of complications. The 5-year survival rate for lupus is over 95%.

Scleroderma

Scleroderma is a chronic autoimmune disease of the connective tissue. Scleroderma is derived from the Greek words “skleros” (hard) and “derma” (skin). In 1836, Giovambattista Fantonetti used the term scleroderma to describe a patient with dark leatherlike skin who lost range of joint motion due to skin tightening. The Scleroderma Foundation estimates that 300,000 people in the United States have scleroderma. The World Scleroderma Foundation reports that scleroderma affects 2.5 million people worldwide. Scleroderma is four times more common in women than in men, and the average age of diagnosis is in the 40s.

Two major forms of scleroderma are recognized. The more common form is localized

scleroderma (LSc), which affects only the skin. The second form is systemic sclerosis scleroderma (SSc), which involves the internal organs and the skin (Figure 2-5 ►).

LSc often appears in the form of waxy patches (morphea) or streaks on the skin (linear scleroderma). This form of scleroderma tends to regress or stop progressing without treatment. However, it can be progressive and disfiguring, requiring treatment to control disease activity. Patients with LSc have a normal lifespan.

SSc is classified into two subsets based on the extent of skin tightening: limited cutaneous SSc (lcSSc) and diffuse cutaneous SSc (dcSSc). In lcSSc (formerly called CREST syndrome), skin tightening is confined to the fingers, hands, and arms below the elbows, and may involve tightening of skin on the feet and legs below the knees. These areas plus skin on the trunk, above the elbows, and on the knees are affected in diffuse cutaneous SSc. Both lcSSc and dcSSc affect internal organs, but patients with dcSSc are at a greater risk for significant organ dysfunction. The 10-year survival rate for lcSSc is 71%, while the 10-year survival rate for dcSSc is 21%.

The most common initial signs and symptoms of scleroderma are secondary Raynaud's phenomenon, thickening and tightening of the skin of the fingers, and pain in two or more joints. Early symptoms can also include heartburn, difficulty swallowing, or shortness of breath.

The etiology of scleroderma is idiopathic, but immune, genetic, environmental, and hormonal

factors play a role. The immune system may stimulate fibroblasts to produce too much collagen, a tough connective-tissue protein. No environmental agent has been shown to cause scleroderma, yet research suggests that exposure to viral infections and certain chemicals may trigger scleroderma in those who are genetically predisposed. Scleroderma is four times more common in women than in men, suggesting that the disease may be linked to estrogen.

Diagnosis begins with a thorough medical history and physical exam. No single test will confirm the diagnosis of scleroderma. Autoantibody testing and biopsy may be performed. Scleroderma has no cure. Scleroderma patients should not use tobacco, should avoid exposure to cold and stress, exercise to help keep skin and joints flexible, eat small frequent meals, protect their skin, and moisturize the skin frequently. Scleroderma cannot be prevented, but several medications can treat and control scleroderma: anti-inflammatory drugs, immunosuppressive drugs, and vasodilators to treat Raynaud's.

Sjögren's Syndrome

Sjögren's syndrome is a chronic, slowly progressive autoimmune disease that affects the exocrine (moisture-producing) glands of the body. The Sjögren's Syndrome Foundation estimates that at least 4 million people in the United States have Sjögren's syndrome; 90% of Sjögren's patients are women.

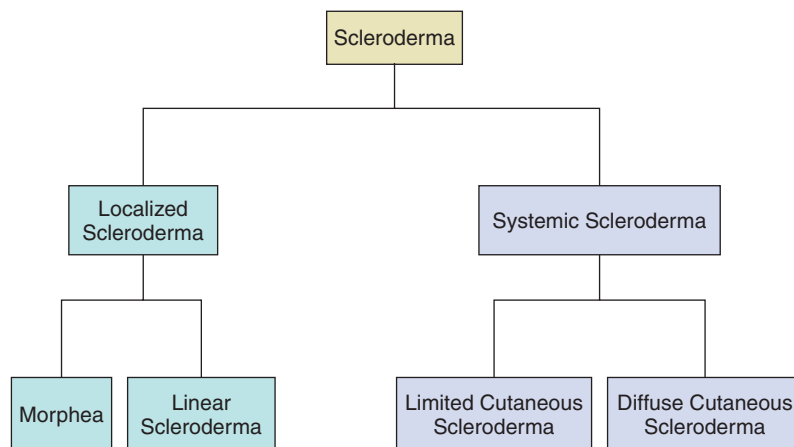


Figure 2-5 ► Types of scleroderma.

About half of the cases are called primary Sjögren's syndrome. The other cases are considered secondary Sjögren's syndrome because they occur along with another disease such as rheumatoid arthritis, lupus, or scleroderma. The hallmark symptoms of Sjögren's syndrome are dry eyes and mouth. Sjögren's may also cause complications in the kidneys, gastrointestinal system, blood vessels, lungs, liver, pancreas, and central nervous system.

The etiology of Sjögren's syndrome is idiopathic. Genetic factors, hormones, and environmental triggers such as viral infections play a role. A first-degree relative with autoimmunity increases the risk for Sjögren's syndrome sevenfold. Sjögren's syndrome often affects women during their childbearing years, suggesting a link between Sjögren's syndrome and estrogen. Sjögren's syndrome is often underdiagnosed or misdiagnosed because its signs and symptoms mimic those of menopause, drug side effects, or diseases such as lupus, rheumatoid arthritis, fibromyalgia, and multiple sclerosis. The average time from the onset of signs and symptoms to diagnosis is nearly 7 years.

Diagnosis begins with a thorough medical history and physical exam. No single test will confirm the diagnosis of Sjögren's syndrome. Tear and saliva tests, autoantibody testing, and lip or salivary gland biopsy may be performed.

Sjögren's syndrome has no cure and cannot be prevented. Several medications alleviate the symptoms: over-the-counter and prescription medications for dry eyes and dry mouth, NSAIDs, immunosuppressive drugs, vasodilators to treat Raynaud's, and other symptomatic treatments to treat heartburn and high blood pressure and to improve breathing.

Allergy

Allergy, or hypersensitivity, is an extreme immune response to a harmless antigen. The normally harmless antigen that causes an allergic response is called an allergen. The allergens that trigger such responses include ragweed or grass pollen, mold, bee venom, poison ivy, latex, or other substances in the environment. The allergic response to allergens causes problems

ranging from the merely annoying, to extreme discomfort, to life-threatening reactions.

Type I Hypersensitivity and Anaphylaxis

There are several different types of hypersensitivity: immediate (or Type I), cytotoxic (or Type II), immune-complex (or Type III), and delayed (or Type IV). Type I is the most common type of allergy. Type I is a local allergy, occurring rapidly where the allergen encounters the body. The Type I reaction is triggered by IgE, the immunoglobulin that responds to the presence of allergens. The allergy problems arise because the IgE also binds to mast cells and induces them to release histamine and other potent chemicals responsible for allergy symptoms. Histamine dilates the blood vessels, causing them to leak plasma into the tissues. This tissue fluid causes edema, or swelling, where the allergen was encountered. Edema localized in the nasal passages results in the familiar congestion and irritation of hay fever. Edema in the skin causes the welts and itching of hives. Inhaled allergens can cause signs and symptoms of asthma. Antihistamines inhibit the effects of histamine. Decongestants do not affect histamine, but they do relieve symptoms.

Prevention PLUS!

Epinephrine Treatment for Life-Threatening Allergic Reactions (Anaphylaxis)

Epinephrine by injection is the treatment of choice for anaphylaxis because it quickly begins working to reverse symptoms of anaphylaxis. Epinephrine constricts blood vessels to increase blood pressure, relaxes smooth muscles in the lungs to reduce wheezing and improve breathing, increases heart rate, and works to reduce hives and swelling that may occur around the face and lips. Certain allergic individuals must carry epinephrine at all times in an epinephrine-injection device, which can be used for self-injection in an emergency.

Think Critically

1. Why is an epinephrine-injection device a prescription medication?
2. Why is an epinephrine-injection device injected into the thigh muscle?

In some people immediate hypersensitivity causes a systemic, acute allergic response (anaphylaxis) that may be life-threatening. Allergens that cause anaphylaxis are found in foods such as peanuts, in latex, in some medications such as penicillin, and in the venom of stinging insects such as wasps and bees. Signs and symptoms of anaphylaxis include a sudden drop in blood pressure, narrowing of the airways, rapid and weak pulse, hives, and nausea and vomiting. Antihistamines, corticosteroids, and epinephrine are used to treat anaphylaxis.

Type II Hypersensitivity

Type II hypersensitivity is called cytotoxic because IgM or IgG causes the destruction of cells. An example of cytotoxic hypersensitivity is the response to an incompatible blood transfusion. A person with type A blood has A antigens on their red cells and antibodies against type B blood in their serum. If such a person receives a type B transfusion, his or her antibodies interact with the antigens on the transfused red blood cells. The red blood cells agglutinate, or clump together, and lyse (rupture). Other examples of cytotoxic hypersensitivity include blood to an Rh- and Rh incompatibility during pregnancy.

Type III Hypersensitivity

Type III hypersensitivity is called immune-complex hypersensitivity. Type III involves antigens combining with many antibodies in the blood, forming a soluble mass of antigens and antibodies known as immune complexes. These immune complexes deposit in tissues and blood vessels where they trigger inflammation and tissue destruction. After a streptococcal infection, immune complexes composed of streptococcal antigens and antibodies might form in the kidneys, where they cause the inflammatory disease glomerulonephritis.

Type IV Hypersensitivity

Type IV hypersensitivities are called delayed hypersensitivities because they take time to develop following exposure to an allergen. The delay occurs because the allergy is due to the

action of T cells, which require time to recognize the allergen, reproduce and differentiate, and bring about the allergy symptoms. Delayed hypersensitivity includes the skin reaction to poison ivy or poison oak, contact dermatitis from wearing latex gloves (Figure 2-6 ►), and the tuberculosis skin test (Figure 2-7 ►). Antihistamines are not effective against delayed hypersensitivity, but corticosteroids provide some relief. Table 2-3 ► summarizes the four types of hypersensitivities.

Allergy Testing and Treatment

A variety of tests can diagnose allergies. Identifying the allergen and the type of allergy permits better treatment and allows a person to avoid known allergens. A commonly used allergy test is the skin test, in which a small amount of the suspected allergen is placed on or below the skin to assess the skin's response to the allergen. Types of skin tests include the skin prick test, intradermal test, and skin patch test. Alternatively, blood tests can detect allergen-specific IgE.



Figure 2-6 ► A severe case of delayed contact dermatitis (Type IV hypersensitivity) from wearing latex gloves.



Figure 2-7 ► Induration measurement in a tuberculin skin test, a type IV hypersensitivity. (Courtesy of the Centers for Disease Control and Prevention)

Allergy symptoms are treated with medicines, although prevention is preferable. People should avoid known allergens, or they may be able to take allergy shots that desensitize them to the allergen. During desensitization, allergens are administered in small amounts, then in gradually increased doses. These allergy shots induce the production of IgG in the blood, which coats the allergen and blocks it from binding to IgE in the tissues.

Immune Deficiency

Acquired Immunodeficiency Syndrome

Acquired immunodeficiency syndrome (AIDS) is a disease of the immune system characterized by a reduction in the number of helper T cells (CD4 cells) and an increased susceptibility to opportunistic infections and certain cancers. Every day, the **human immunodeficiency virus (HIV)** infects almost 7,000 people—nearly 300 people each hour—with the development of AIDS being a possible eventual outcome of HIV infection. In 2011 AIDS killed 1.7 million people, and today 34 million people worldwide live with HIV/AIDS, 68% of whom reside in sub-Saharan Africa. Since the epidemic began 30 years ago, more than 60 million people have contracted HIV and nearly 30 million have died of AIDS. Risk factors for HIV/AIDS include having unprotected sex, having multiple sex partners, having another sexually transmitted infection, IV drug use, being uncircumcised, and being born to an infected mother.

Stages of HIV Infection

HIV infection has four distinct stages. The first is the primary HIV infection stage, which follows exposure to HIV, lasts a few weeks, and is accompanied by a short flulike illness. The second stage is the clinically asymptomatic stage, which lasts an average of 10 years. During this stage patients do not have symptoms, but they can transmit the infection, and HIV continues to

TABLE 2-3 Types of Hypersensitivities

Type	Mechanism	Response time	Example
I	Excess IgE bound to mast cells causes release of histamine	15–30 minutes	Hay fever, hives
II	IgM and IgG cause destruction of foreign cells	Minutes to hours	Transfusion of an incompatible blood type, erythroblastosis fetalis
III	Immune complexes are deposited in tissue and vessels	3–8 hours	Glomerulonephritis
IV	Chemicals released by activated T cells	48–72 hours	Poison ivy or oak, tuberculin test

Promote Your Health

HIV Testing

The key to living a healthy life with HIV is being diagnosed early. The following are behaviors that increase your chances of getting HIV. If you answer “yes” to any of them, you should definitely get an HIV test. If you continue with any of these behaviors, you should be tested every year.

- Have you injected drugs or steroids or shared equipment (such as needles, syringes, works) with others?
- Have you had unprotected vaginal, anal, or oral sex with men who have sex with men, multiple partners, or anonymous partners?
- Have you exchanged sex for drugs or money?
- Have you been diagnosed with or treated for hepatitis, tuberculosis (TB), or a sexually transmitted disease (STD), such as syphilis?
- Have you had unprotected sex with someone who could answer “yes” to any of the above questions?

multiply, infecting and killing helper T cells. The third stage is called symptomatic HIV, when an HIV-infected patient experiences symptoms but has not developed AIDS. Signs and symptoms can persist for several years and include diarrhea, fever or night sweats, fatigue or joint pain, oral infections, enlarged lymph nodes, and skin problems. The fourth and final stage is progression from HIV to AIDS. At this stage the patient has one of the AIDS indicator diseases and a helper T cell count of less than 200. AIDS indicator diseases are infections that do not normally occur in a person protected by a healthy immune system. Examples of these infections include pneumonia caused by the fungus *Pneumocystis jirovecii*.

The cause of AIDS is the human immunodeficiency virus, a retrovirus that carries its genetic information as RNA rather than DNA (Figure 2–8 ►). HIV is transmitted via contaminated body fluids, including blood, semen, vaginal secretions, and breast milk. Therefore, HIV is transmitted by unprotected anal, oral, or vaginal intercourse, during birth, through breastfeeding, and by sharing needles. The virus infects and kills helper T cells, crippling the body’s immune response and leaving the body susceptible to infections and tumors that a healthy immune system can easily control.

HIV is diagnosed using ELISA to detect HIV antibodies in the blood. Most people produce

antibodies against HIV within 3 months of being infected. A positive ELISA is repeated and the result confirmed using the Western blot. (The ELISA and Western blot tests were described earlier in this chapter.) Anonymous free HIV testing is available at local health departments throughout the United States.

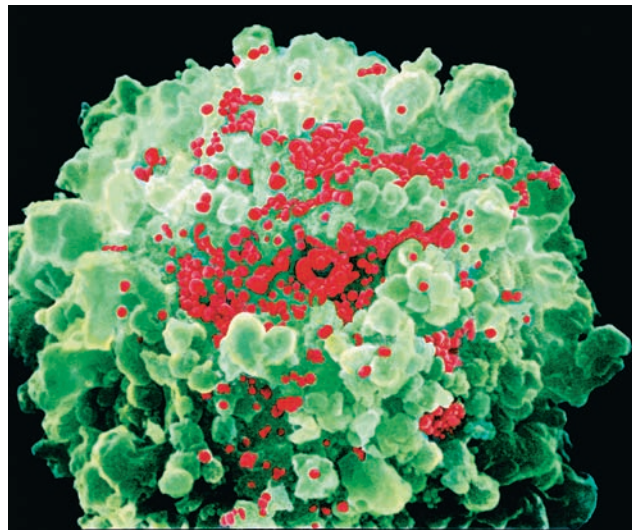


Figure 2–8 ► Colored scanning electron micrograph (SEM) of a helper T cell (green) with HIV viruses (red) budding off the helper T cell. (National Institute for Biological Standards and Control (UK)/Science Photo Library/Photo Researchers, Inc.)

Antiretroviral therapy (ART) is the recommended treatment for HIV infection and should be started as soon as possible. ART controls replication of the virus and slows the progression of HIV-related disease. ART includes several types of drugs: reverse transcriptase inhibitors interfere with the conversion of HIV RNA to DNA; protease inhibitors stop the assembly of new HIV viruses; fusion inhibitors prevent the fusion of HIV to helper T cells; entry inhibitors block HIV from entering helper T cells; and integrase inhibitors interfere with HIV inserting its genetic material into human cells.

ART combines three or more anti-HIV medications in a daily regimen. ART does not cure HIV infection, and individuals taking these medications can still transmit HIV to others. The World Health Organization (WHO) and the Joint United Nations Programme on HIV/AIDS (UNAIDS) estimate that at least 15 million people worldwide were in need of ART therapy in 2010. As of the end of 2010, 6.6 million people had access to ART; this is a 16-fold increase in the number of people receiving ART in developing countries between 2003 and 2010.

An effective vaccine for HIV is not yet available. Vaccine development is complicated by great genetic variation among strains of HIV and the virus's ability to quickly mutate. Vaccines to date have not been successful in stimulating HIV antibody production.

The WHO suggests the following for HIV prevention:

- Abstinence
- Monogamy
- Condom use
- Testing and counseling for HIV
- Male circumcision
- Sterile needles and syringes for each injection for IV drug use
- ART therapy
 - Preexposure prophylaxis for an HIV-negative partner
 - Postexposure prophylaxis for accidental exposure
 - To prevent mother-to-child transmission

Prevention PLUS!

FDA Approves HIV Preventative Drug

In July 2012 the U.S. Food and Drug Agency approved the marketing of the first drug shown to curb the transmission of the HIV virus. The drug, which is actually a combination of two medicines, prevents HIV from altering the genetic material of healthy CD4 cells. This prevents the cells from producing new virus and decreases the amount of virus in the body. The daily pill is intended for an estimated 415,000 Americans whose sexual activity puts them at the highest risk for contracting HIV. Studies showed that when taken daily the drug reduced the risk of HIV infection by 42% among HIV-negative men or transgender women who had unprotected sex with multiple partners, including some HIV carriers. In another trial involving heterosexual couples in which one partner was infected, the drug reduced the risk of infections by 75%. Used daily, the drug will cost \$13,900 a year for each patient but is cost-effective when compared to the expense of medical complications and lifelong drugs to treat HIV and AIDS.

Think Critically

1. Is the HIV preventative drug a cure for HIV and AIDS?
2. Is the HIV preventative drug a substitute for safer sex practices?

Cancers of the Immune System

Hodgkin's Lymphoma

Hodgkin's lymphoma, also known as Hodgkin's disease, is a cancer of the immune system. Hodgkin's lymphoma is most frequently diagnosed in teens and adults between the ages of 15 and 40 and after age 55. The American Cancer Society estimates 9,290 cases of Hodgkin's lymphoma in 2013.

Hodgkin's lymphoma is marked by the presence of a type of cell called the Reed-Sternberg cell (Figure 2-9 ►). Hodgkin's lymphoma includes a wide variety of diverse subtypes, each of which may have a distinct treatment and prognosis.

Risk factors include certain viral infections (Epstein-Barr and HIV), a weakened immune system, and a family history of Hodgkin's lymphoma. Signs and symptoms include painless swelling of lymph nodes (neck, armpit, or groin), fatigue, unexplained fever, soaking night sweats, itchy skin, coughing, trouble breathing, chest

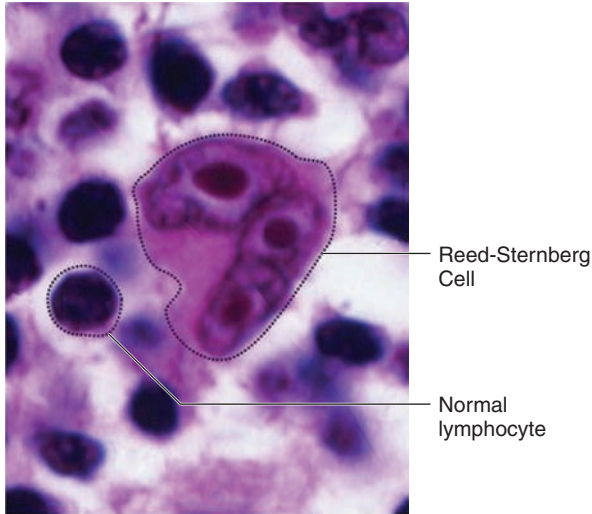


Figure 2-9 ► Reed-Sternberg cells are large, abnormal lymphocytes that may contain more than one nucleus. These cells are found in Hodgkin's lymphoma. (National Cancer Institute)

pain, and unexplained weight loss. **Figure 2-10** ► shows greatly enlarged cervical lymph nodes from Hodgkin's lymphoma.

The etiology of Hodgkin's lymphoma is idiopathic. Hodgkin's lymphoma diagnosis is based on a physical exam, complete blood count, and biopsy to confirm the presence of Reed-Sternberg cells. Imaging tests and a bone marrow biopsy may be used to stage the disease.

Hodgkin's lymphoma may be treated with chemotherapy, radiation therapy, and bone marrow or stem cell transplant. Survival of Hodgkin's lymphoma is related to the extent of disease at diagnosis. The 5-year survival for all stages of the disease combined is estimated at 65–90%. Unfortunately, Hodgkin's lymphoma cannot be prevented.

Non-Hodgkin's Lymphoma

Non-Hodgkin's lymphoma is cancer of the lymphocytes. The American Cancer Society estimates that 355,900 new cases will occur worldwide and 69,740 cases will occur in the United States in 2013. Non-Hodgkin's lymphoma



Figure 2-10 ► Greatly enlarged cervical lymph nodes due to Hodgkin's lymphoma. (Centers for Disease Control and Prevention/Robert E. Sumpter)

is most frequently diagnosed in adults age 60 and older. Like Hodgkin's disease, non-Hodgkin's lymphoma includes a wide variety of subtypes.

Risk factors for non-Hodgkin's lymphoma include a weakened immune system and certain infections (human T-cell lymphotropic virus, Epstein-Barr virus, *Helicobacter pylori*, hepatitis C, HIV). Signs and symptoms include painless swelling of lymph nodes (neck, armpit, or groin), fatigue, pain, unexplained fever, soaking night sweats, itchy skin, coughing, trouble breathing, chest pain, swelling or a feeling of fullness in the abdomen, and unexplained weight loss. **Figure 2-11** ► shows a large facial tumor caused by malignant Burkitt's lymphoma (a non-Hodgkin's lymphoma).

The etiology of non-Hodgkin's lymphoma is idiopathic. Diagnosis of non-Hodgkin's lymphoma is based on a physical exam, complete blood count, lactate dehydrogenase test (tests for tissue damage), and biopsy. Imaging tests, bone marrow biopsy, and a lumbar puncture are used to stage the disease.

Non-Hodgkin's lymphoma that is slow-growing may not require treatment for years. In these



Figure 2–11 ► Large facial tumor due to malignant Burkitt’s lymphoma, a non-Hodgkin’s lymphoma. (Centers for Disease Control and Prevention/Robert S. Craig)

cases, “watch and wait” may be a treatment option. Treatment may include radiation therapy, chemotherapy, anti-inflammatory medication, stem cell transplant, and monoclonal antibody therapy to tag cancer cells for destruction.

Prognosis varies and depends on the stage of the cancer, the subtype, patient age, and overall health of the patient. Screening and early diagnosis are important because non-Hodgkin’s lymphoma cannot be prevented.

Resources

American Academy of Allergy Asthma and Immunology: www.aaaai.org
 Global HIV Prevention Working Group: www.globalhivprevention.org/index.html
 Joint United Programme on HIV/AIDS: www.unaids.org/en
 Lupus Foundation of America: www.lupus.org
 Scleroderma Foundation: www.scleroderma.org
 Sjögren’s Syndrome Foundation: www.sjogrens.org
 World Scleroderma Foundation: www.worldsclerodermafoundation.net/home/

Diseases at a Glance

Disease	Etiology	Signs and symptoms
Lupus	Idiopathic	<p>SLE – Fatigue, arthritis, fever, butterfly rash across cheeks and nose, photosensitivity, secondary Raynaud's phenomenon, mouth or nose ulcers</p> <p>Cutaneous – Raised, scaly and red, but not itchy rash; butterfly rash across cheeks and nose</p> <p>DILE – Similar to SLE but rarely affects organs</p> <p>Neonatal – Rash</p>
Scleroderma	Idiopathic	<p>Secondary Raynaud's phenomenon, thickening and tightening of the skin, pain in two or more joints, heartburn, difficulty swallowing, shortness of breath</p>
Sjögren's syndrome	Idiopathic	Dry eyes and mouth
AIDS	HIV	<p>Primary HIV – Flulike illness</p> <p>Clinically asymptomatic stage – None</p> <p>Symptomatic stage – Diarrhea, fever or night sweats, fatigue or joint pain, oral infection, enlarged lymph nodes, skin problems</p> <p>AIDS – One of the AIDS indicator diseases, helper T cell count less than 200</p>
Hodgkin's lymphoma	Idiopathic	Painless swelling of lymph nodes, fatigue, unexplained fever, soaking night sweats, itchy skin, coughing, trouble breathing, chest pain, unexplained weight loss
Non-Hodgkin's lymphoma	Idiopathic	Painless swelling of lymph nodes, fatigue, unexplained fever, soaking night sweats, itchy skin, coughing, trouble breathing, chest pain, unexplained weight loss, pain, swelling or a feeling of fullness in the abdomen, unexplained weight loss.

Diagnosis	Treatment	Prevention
Medical history, physical exam, complete blood count, urinalysis, autoantibody testing, measurement of general levels of inflammation, biopsy	NSAIDs, corticosteroids, antimalarial drugs, immunosuppressive drugs, monoclonal antibody therapy	Not preventable
Medical history, physical exam, autoantibody testing, biopsy	NSAIDs, corticosteroids, immunosuppressive drugs, vasodilators	Not preventable
Medical history, physical exam, tear and saliva tests, autoantibody testing, biopsy	OTC and prescriptions for dry eyes and mouth, NSAIDs, corticosteroids, immunosuppressive drugs	Not preventable
HIV+, AIDS indicator disease, helper T cell count less than 200	ART therapy	Abstinence, monogamy, condom use, male circumcision, sterile needles and syringes for each injection for IV drug use, testing and counseling for HIV, ART therapy
Physical exam, complete blood count, biopsy to confirm Reed-Sternberg cells	Chemotherapy, radiation, bone marrow or stem cell transplant	Not preventable
Physical exam, complete blood count, lactate dehydrogenase test, biopsy	Radiation, chemotherapy, stem cell transplant, monoclonal antibody therapy	Not preventable

Interactive Exercises

Cases for Critical Thinking

1. Tom was not vaccinated against the rubella virus and is concerned he may have contracted measles. His physician takes a blood sample and sends it to a lab to measure rubella antibody levels. The results show an elevated level of IgM antibodies to the rubella virus but very few IgG antibodies to the virus. Did Tom contract measles? How do you know? Did Tom contract the rubella virus recently? How do you know?
2. A crime scene investigator finds a body of a woman and discovers animal bites on the victim's body. The investigator examines the bites and sees they are not inflamed. Did the animal bites happen before or after the woman died?
3. Some people with decreased IgA exhibit recurrent sinus and respiratory infections. Why?
4. Explain why HIV's attack on helper T cells devastates the entire immune system.

Multiple Choice

1. The body's ability to resist disease is _____.
 - a. specific immunity
 - b. nonspecific immunity
 - c. immunity
 - d. antigen
 - e. tolerance
2. A type of leukocyte that recognizes and eliminates viral infected cells and cancer cells is _____.
 - a. helper T cell
 - b. cytotoxic T cell
 - c. natural killer cell
 - d. memory cell
 - e. plasma cell
3. Defense against extracellular antigens via antibodies is called _____.
 - a. humoral immunity
 - b. cell-mediated immunity
 - c. plasma cells
 - d. tolerance
 - e. suppression
4. Nonspecific immunity includes all the following except
 - a. fever
 - b. cell-mediated immunity
 - c. phagocytosis
 - d. interferons
5. Which is any foreign substance that when introduced into the body is recognized as nonself and activates the immune system?
 - a. antigen
 - b. antibody
 - c. antibiotic
 - d. fever
6. Which cells secrete antibodies during the immune response?
 - a. helper T cells
 - b. memory cells
 - c. plasma cells
 - d. cytotoxic T cells
7. The response to poison ivy is an example of which type of hypersensitivity?
 - a. I
 - b. II
 - c. III
 - d. IV
8. Which antibody is produced in excess during an allergic response?
 - a. IgE
 - b. IgG
 - c. IgM
 - d. IgA

9. HIV infects and kills _____.
 a. B cells
 b. cytotoxic T cells
 c. helper T cells
 d. natural killer cells

10. Which cells are involved in both cellular and humoral reactions during an immune response?
 a. cytotoxic T cells
 b. natural killer cells
 c. plasma cells
 d. helper T cells

True or False

- _____ 1. HIV can be transmitted through saliva.
 _____ 2. Fever is part of specific immunity.
 _____ 3. IgG is the principal component of the primary and secondary response to an antigen.
 _____ 4. Antibodies provide humoral immunity.
 _____ 5. Cell-mediated immunity depends on the activities of B cells.
 _____ 6. Cytotoxic T cells kill via phagocytosis.
 _____ 7. IgE stimulates chemicals that mediate inflammation and allergy.
 _____ 8. In autoimmunity antibodies are made against self antigens.
 _____ 9. Anaphylactic shock is a mild allergic reaction.
 _____ 10. Type I hypersensitivities involve IgM or IgG and cause destruction of foreign cells.

Fill-Ins

1. In _____ leukocytes surround and ingest foreign material.
 2. _____ are antiviral proteins produced by some animal cells after viral infection.
 3. _____ is a chronic autoimmune disease of the connective tissue.
 4. _____ is the first antibody produced.
 5. _____ immunity is present at birth.
 6. _____ is a group of plasma proteins that assist in the destruction of foreign cells.
 7. _____ is an extreme immune response to an antigen.
 8. _____ is a cancer of the immune system that is marked by the presence of Reed-Sternberg cells.
 9. The causative agent of AIDS is _____.
 10. _____ immunity develops in response to contact with an antigen.

Chapter 3

Infectious Diseases

Learning Objectives

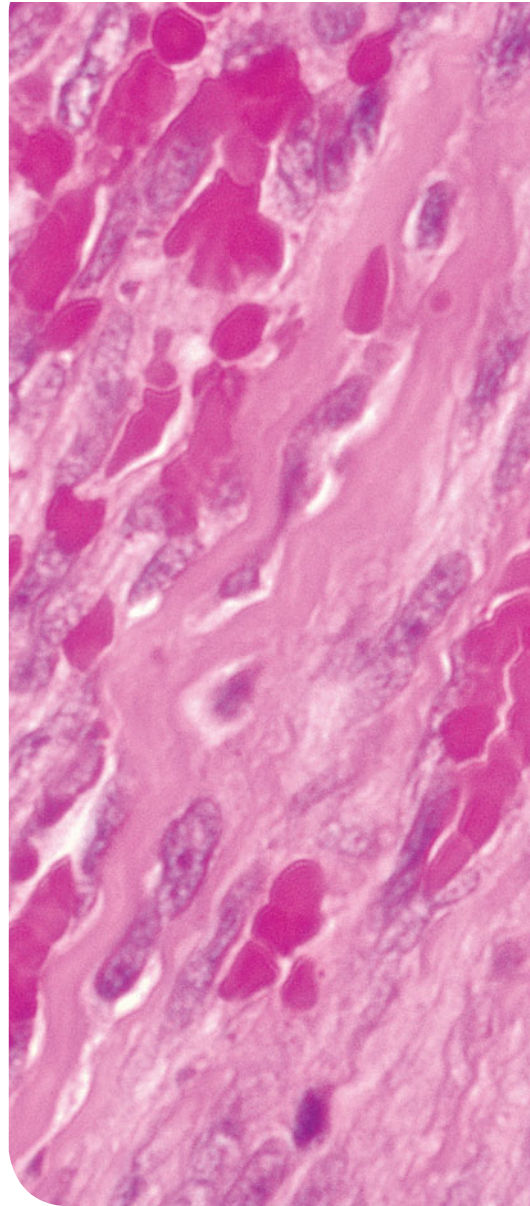
After studying this chapter, you should be able to

- Define infectious disease and its terminology
- Explain how infectious diseases are transmitted
- Describe and compare the characteristics of prions, viruses, bacteria, protozoa, fungi, and helminths
- Define nosocomial infections
- Explain treatment for bacterial, viral, fungal, and parasitic infectious diseases
- Understand the appropriate use of antibiotics and explain the problem of antibiotic resistance
- Describe examples and causes of emerging and reemerging infectious diseases
- Identify common childhood vaccine-preventable infectious diseases

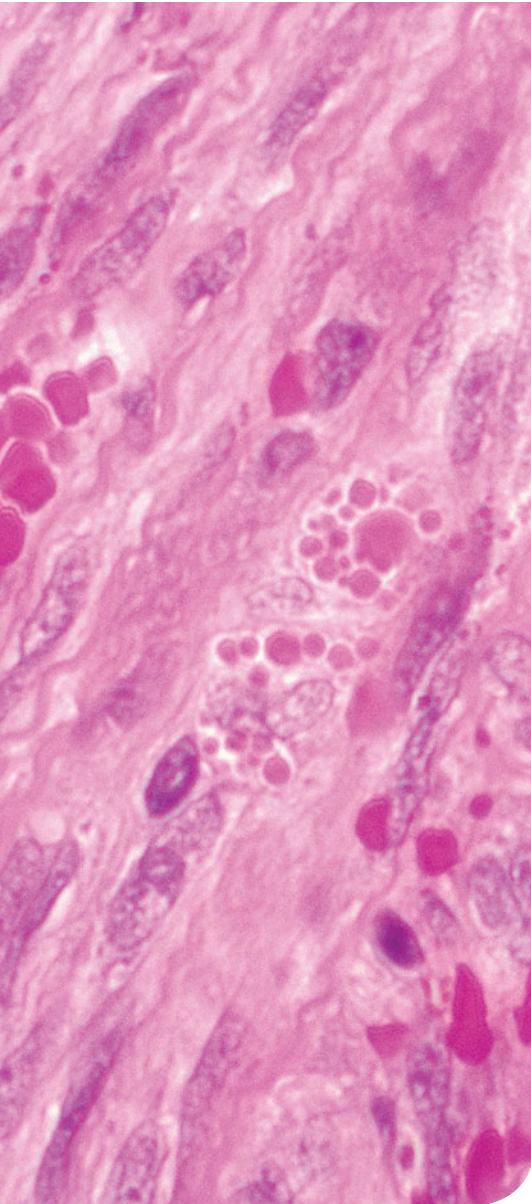
Fact or Fiction?

Thanks to modern medicine, notorious infectious diseases such as tuberculosis are things of the past.

Fiction: Population growth, climate and weather change, antibiotic resistance, modern travel, human behavior, and other factors are responsible for the reemergence of many infectious diseases, including tuberculosis.



Kaposi's sarcoma. (Courtesy of the Centers for Disease Control and Prevention/Dr. Edwin P. Ewing, Jr., 1979)



Disease Chronicle

Spanish Flu Pandemic

The influenza pandemic of 1918–1919 has been called the most devastating pandemic in recorded world history. Known as Spanish flu, the influenza pandemic of 1918–1919 was a global disaster. The pandemic killed an estimated 20–40 million people worldwide and 675,000 in the United States; a quarter of the population of the United States and a fifth of the population of the world was infected. The mortality rate was 2.5% compared to the previous influenza pandemics, which had mortality rates of 0.1%. One of the great unsolved mysteries surrounding the 1918 pandemic is why it tended to kill healthy adults. In contrast, the greatest mortality for seasonal influenza occurs among young children, older adults, and those with chronic health conditions. Scientists believe that the return of a virus equivalent in pathogenicity to the virus of 1918 could cause another pandemic.

Introduction

Despite medical advances that have produced drugs and vaccines that are safe and effective, **infectious diseases** remain a major cause of death, disability, and social and economic upheaval for millions around the world. Illness and death from infectious diseases are particularly tragic because they are largely preventable and treatable. More than 90% of deaths from infectious diseases worldwide are caused by a handful of diseases (Table 3–1 ►). The World Health Organization reports that in high-income countries, only one of the top 10 causes of death is an infectious disease; in contrast, among low- and middle-income countries, infectious diseases account for 4 of the 10 leading causes of death. Poverty, lack of access to health care, antibiotic resistance, evolving human migration patterns, new infectious agents, and changing environmental and developmental activities all contribute to the growing impact of infectious diseases. This chapter describes the nature of infectious diseases, surveys the types of microorganisms responsible for infections, explains their transmission, and discusses treatment.

Principles of Infectious Disease

Infectious diseases are caused by microorganisms known as pathogens. A **pathogen** is

a disease-causing microorganism that grows in or on the body, damaging tissue, inducing inflammation, and triggering familiar signs and symptoms associated with particular infections. A fitting name, *pathogen* is derived from Greek words that mean “to cause suffering.”

Infectious diseases transmitted directly by human contact are said to be **contagious** or **communicable**. Measles and influenza are well-known contagious diseases. Some infectious diseases are not transmitted directly from person to person and are not contagious. For example, rabies can be transmitted by the bite of a rabid raccoon, and cholera is transmitted by drinking fecal-contaminated water.

Epidemiology is the study of the transmission, occurrence, distribution, and control of disease. Epidemiologists track the **incidence** of disease, the number of new cases of a disease in a population. In doing so, patterns are revealed, as when influenza incidence increases in winter and subsides in summer or when Lyme disease incidence increases in summer and subsides in winter. The number of existing cases of a disease is known as its **prevalence**, and this information can show how significant the disease is in a certain population. When a disease always occurs at low levels in a population, it is said to be **endemic**. Sexually transmitted infectious diseases are endemic diseases. If a disease occurs in unusually large numbers over a specific area, it is said to be **epidemic**. Influenza occurs as epidemics. When an epidemic has spread to include several areas worldwide, it is said to be **pandemic**. HIV/AIDS is considered to be pandemic. When a disease suddenly occurs in unexpected numbers in a limited area and then subsides, this is described as an **outbreak**.

Notifiable diseases are certain infectious diseases that physicians must report to the Centers for Disease Control and Prevention. This ensures tracking and identification of disease occurrence and patterns. Chlamydia infections were not notifiable before 1998. After these infections were classified as notifiable, it was discovered that the number of chlamydial infections surpassed gonorrhea. Other notifiable infectious diseases include measles, mumps, polio, tuberculosis, Legionnaires’ disease, and tetanus.

TABLE 3–1 Leading Causes of Death Due to Infectious Diseases

Infectious Disease	Number of Deaths
Total	8.72 million
Lower respiratory infections	3.46 million
Diarrheal diseases	2.46 million
HIV/AIDS	1.77 million
Tuberculosis	1.34 million
Malaria	0.82 million
Measles	0.15 million

Source: World Health Organization, Global Burden of Disease, 2011.

Transmission of Infectious Diseases

The source of an infectious agent is known as a **reservoir**. Reservoirs include humans, animals, insects, soil, and water. For example, humans are the reservoir for the measles virus because it does not infect other organisms. People who harbor an infectious agent but do not have signs or symptoms are known as carriers. Carriers play an important role in the transmission of pathogens.

Horizontal transmission describes transmission of an infectious disease from a reservoir to a susceptible human. Horizontal transmission occurs either directly or indirectly. Direct transmission occurs when an individual is infected by contact with the reservoir. For example, some infections are transmitted by touching, kissing, or engaging in sexual contact with an infected person, or being bitten by an infected animal or insect. Diseases that are transmitted primarily by direct contact include ringworm, HIV/AIDS, the common cold, and influenza. Transmission by direct contact also occurs when infectious agents are expelled in droplets produced by sneezing or coughing. These contaminated respiratory droplets can travel up to 3 feet and can cause an infection if inhaled. Diseases spread by respiratory droplets include pneumonia and influenza.

Indirect transmission occurs when a pathogen can withstand the environment outside its host for a long period of time before infecting another individual. Some infectious agents survive in tiny airborne droplets for prolonged periods and can travel more than 3 feet from the reservoir. Some of these pathogens can remain viable in the environment for some time before infecting another person. Tuberculosis and measles can be transmitted in this way. Contaminated inanimate objects are called **fomites**, and these can also transmit infection (e.g., a tissue used to wipe the nose of an individual who has a cold, syringes, or utensils). Intravenous drug users who share needles can transmit infectious agents such as hepatitis B, hepatitis C, and HIV via indirect contact.

Food and beverages transmit infectious disease. The fecal–oral route of transmission occurs when food and beverages are contaminated

and then ingested. For example, sewage-contaminated water is a source of infection if used for drinking, washing, or preparing foods. Gastrointestinal diseases such as cholera, rotavirus infection, and giardiasis are transmitted this way.

Other infectious diseases are transmitted from one generation to the next, as when syphilis, HIV/AIDS, or ophthalmia neonatorum (an eye infection) are transmitted to newborns from infected mothers. This type of route is called **vertical transmission**.

To cause disease, microorganisms must enter the human host. The respiratory tract is among the most frequently used portals of entry for pathogens, including those that cause the common cold, influenza, and tuberculosis. Pathogens also use the gastrointestinal and genitourinary tracts as portals of entry. Punctures, injections, bites, and surgery can allow microorganisms to be deposited directly into the tissues below the skin. This is known as the **parenteral** route and is used for the transmission of HIV and hepatitis B.

Nosocomial Infections

Nosocomial, or hospital-acquired, infections are infections acquired in a health care facility. The Centers for Disease Control and Prevention estimates that 1.7 million patients in the United States contract a nosocomial infection each year and 99,000 die as a result. The most common are urinary tract infections, accounting for 32% of nosocomial infections; 22% are infections at the surgical site, 15% are lung infections such as pneumonia, and 14% are bloodstream infections (sepsis). Rates of nosocomial infections are markedly higher in developing countries as a result of poor infection control practices, limited resources, and overcrowding of hospitals.

The microorganisms that cause nosocomial infections can come from the patient's normal flora, contact with health care staff, contaminated instruments or needles, and the health care environment. Because hospital stays are short, patients may be discharged before the infection becomes apparent.

Health care facilities are a major reservoir for a variety of opportunistic pathogens that can cause nosocomial infections. A weakened patient

is an ideal target for an opportunistic pathogen. A patient's resistance to infection can be reduced as a result of disease or compromised immunity. Burns, surgical wounds, injections, invasive diagnostic procedures, ventilators, intravenous therapy, and catheters increase the risk of infection. The principal routes of transmission of nosocomial infections are contact with health care staff, contact with contaminated instruments, and through the hospital's ventilation system.

The 100 trillion microorganisms that are commonly present in and on our bodies comprise our **normal flora** or **microbiota**. Normal flora do not harm us and in some cases help us by preventing overgrowth of harmful microorganisms and by producing vitamins. Normal flora may become harmful if an opportunity to do so arises. In this case, normal flora become opportunistic pathogens or opportunists. Opportunists typically do not cause disease in their usual location in a healthy person but may cause disease in surgical wounds or if the host is weakened or immune-compromised (e.g., a patient with HIV/AIDS).

According to the Centers for Disease Control and Prevention, handwashing is the single most important means of preventing the spread of nosocomial infections. Education of health care facility staff and visitors about basic infection control measures, isolation of patients, sterilization of equipment, use of disposable materials, and prescription of antibiotics only when necessary can help control nosocomial infections.

Control of Infectious Diseases

Control of infectious diseases can be achieved by preventing transmission. **Isolation** of infected persons in hospitals and self-imposed isolation, such as when a person with influenza remains home in bed, can be effective. **Quarantine** is the separation of persons who may or may not be infected from healthy people until the period of infectious risk is passed.

Disinfection of potentially infectious materials is necessary to prevent transmission. Medical and dental implements need disinfection to remove human pathogens after use. Health care personnel must disinfect all surfaces of a patient's room, change and disinfect linens, and,

above all, wash their hands before and after contact with patients.

Everyone should practice respiratory etiquette and handwashing. Respiratory etiquette controls the spread of influenza, cold, tuberculosis, and other respiratory diseases. The elements are simple. One should sneeze or cough into a handkerchief, a tissue, or upper arm or elbow. Never sneeze or cough into the hands. After coughing or sneezing, always wash hands and discard tissues. Handwashing prevents foodborne illnesses as well as those transmitted by respiratory droplets. One must wash hands before and after preparing meals and after handling raw meat and eggs.

Of all methods, vaccination may be the most effective way to protect personal and public health. Vaccination eliminated smallpox from Earth—the only method that has been able to completely eradicate an infectious disease. Vaccines are safe and effective and prevent some of the most serious diseases we know. We discuss commonly used vaccines later in this chapter.

Bloodborne Pathogens

The Occupational Safety and Health Administration (OSHA) estimates that 5.6 million workers in the health care industry and related occupations are at risk of occupational exposure to bloodborne pathogens, including human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Precise data are not available on the annual number of needlestick

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Handwashing

According to the Centers for Disease Control and Prevention, handwashing is the single most important means of preventing the spread of infection. The CDC provides the following instructions for correct handwashing:

- Wet hands.
- Apply soap and rub vigorously for at least 20 seconds.
- Rinse with water.
- Dry thoroughly with disposable paper towel.
- Use paper towel to turn off faucet.

and other percutaneous injuries among U.S. health care workers; however, estimates indicate that 600,000–800,000 such injuries occur annually, and about half of these injuries go unreported.

The rate of HBV transmission to susceptible health care workers ranges from 6–30% after a single needlestick exposure to an HBV-infected patient. However, such exposures are a risk only for health care workers who are not immune to HBV; health care workers who have antibodies to HBV either from preexposure vaccination or prior infection are not at risk. In addition, if a susceptible worker is exposed to HBV, postexposure prophylaxis with hepatitis B immune globulin and initiation of hepatitis B vaccine is more than 90% effective in preventing HBV infection.

The average risk for infection after a needlestick or cut exposure to HCV-infected blood is

approximately 1.8%. There is no vaccine against HCV, and there is no postexposure prophylaxis treatment available that reduces transmission. The average risk of HIV infection after needlestick exposure or cut exposure to HIV-infected blood is 0.3%. There is no vaccine against HIV; however, the use of antiretroviral drugs after occupational exposures reduces the chance of HIV transmission.

The OSHA Bloodborne Pathogens Standard is aimed at protecting health care workers from exposure. The standard provides for regular employee training and a system for communication of hazards in the workplace. Where bloodborne pathogens are likely to be encountered, a workplace must adopt the practice of Standard Precautions (Table 3–2 ►). These precautions apply in all health care settings and under all circumstances.

TABLE 3–2 Standard Precautions for the Care of All Patients in All Health Care Settings

Component	Recommendations
Hand hygiene	Wash hands after touching blood, body fluids, secretions, excretions, contaminated items; immediately after removing gloves; between patient contacts.
Personal Protective Equipment (PPE)	
Gloves	Wear gloves for touching blood, body fluids, secretions, excretions, contaminated items; for touching mucous membranes and nonintact skin.
Gown	Wear gown during procedures and patient-care activities when contact of clothing/exposed skin with blood/body fluids, secretions, and excretions is anticipated.
Mask, eye protection (goggles), face shield	Wear mask during procedures and patient-care activities likely to generate splashes or sprays of blood, body fluids, and secretions, especially suctioning, endotracheal intubation.
Soiled patient-care equipment	Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; perform hand hygiene.
Environmental control	Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient-care areas.
Textiles and laundry	Handle in a manner that prevents transfer of microorganisms to others and to the environment.
Needles and other sharps	Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; place used sharps in puncture-resistant container.

(continued)

TABLE 3–2 (continued)

Component	Recommendations
Other Work Practices	
Patient resuscitation	Use mouthpiece, resuscitation bag, or other ventilation devices to prevent contact with mouth and oral secretions.
Patient placement	Prioritize for single-patient room if patient is at increased risk of transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk of acquiring infection or developing adverse outcome following infection.
Respiratory hygiene/cough etiquette	Instruct symptomatic persons to cover mouth/nose when sneezing/coughing; use tissues and dispose in no-touch receptacle; observe hand hygiene after soiling of hands with respiratory secretions; wear surgical mask if tolerated or maintain spatial separation, >3 feet if possible.
Source: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 <i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i> . www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf	

Survey of Pathogenic Microorganisms

Humans can be infected by a variety of pathogens, ranging from tiny, single-celled bacteria to macroscopic, complex worms (Figure 3–1 ►).

Viruses

Viruses are infectious particles with a core of genetic material (either RNA or DNA) wrapped in a protein coat (**capsid**). Some viruses also have a lipid membrane surrounding their capsid that plays a role in host cell recognition and spikes that aid in attachment to cells. Viruses are not considered living organisms because they do not independently grow, metabolize, or reproduce. Viruses must carry out their life processes by entering cells and directing the cells' energy, materials, and organelles for these purposes.

Some viruses, such as cold viruses, target cells of the respiratory epithelium. Others, such as herpes viruses, reproduce in nervous tissue. Signs and symptoms of infection result from the way these viruses reproduce in cells or from the way the immune system responds to viral infection. Some viruses cause infected cells to lyse, or rupture, as when HIV infects and reproduces within T cells. The resultant T-cell deficiency leads to the immunodeficiency in AIDS. Other viruses sustain a **latent infection**, whereby the

viruses insert themselves in cells, do not reproduce, and elicit no signs and symptoms. Later, a trigger—such as stress, infection with another pathogen, or a weakened immune defense—activates the viruses. Signs and symptoms of the disease then manifest themselves as the viruses reproduce. This pattern is seen in the recurrence of herpes infections. Other viruses cause abnormal cell growth because the viral genetic material interferes with the cell's growth-control genes. For example, human papillomavirus infection is linked to cervical cancer.

Bacteria

Bacteria are microscopic, single-celled organisms. A simple structure (no nucleus or membranous organelles) and small size (1–10 μm) differentiate bacteria from other single-celled organisms. Although often described as simple, they are far from primitive, for they have adapted to a wide variety of habitats and have evolved complex strategies for infecting and surviving in the human body.

Bacteria have **cell walls**, a rigid layer of organic material surrounding their delicate cell membranes. These walls give bacteria their characteristic shapes. Bacteria may have spherical (round) cells called **cocci**, rod-shaped cells called **bacilli**, spiral-shaped cells called **spirilla**, corkscrew-shaped cells called **spirochetes**, or comma-shaped cells

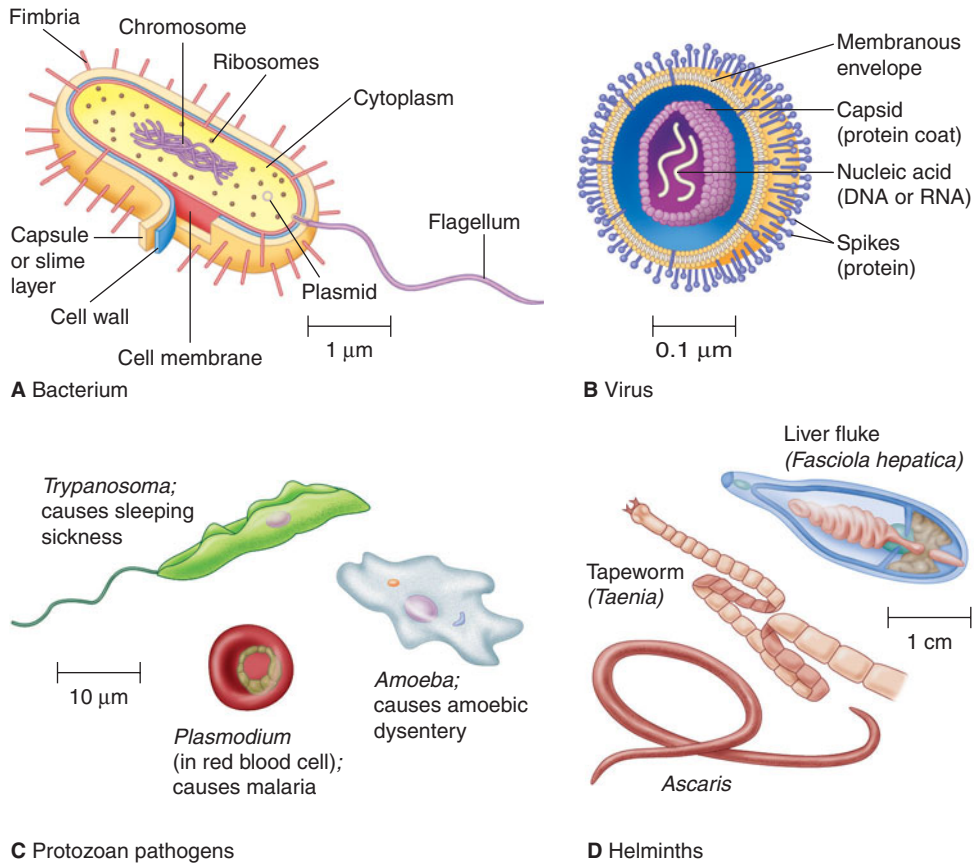


Figure 3-1 ▶ Pathogenic microorganisms include (A) bacteria, (B) viruses, (C) protozoa, and (D) helminths.

called **vibrios**. The walls protect these cells; should walls be disrupted, cells are susceptible to bursting, or lysis. Penicillin interferes with correct cell wall construction of certain types of bacteria, causing them to lyse. Thickness and chemical composition of the cell wall accounts for the way certain cells stain during the **gram stain** procedure. During the gram stain, thick-walled cells turn purple and thin-walled cells become pink; thus, bacteria can be identified with a microscope using this technique (Figure 3-2 ▶). Identification is critical to obtain an accurate diagnosis and effective treatment of an infection.

Other bacteria that do not fit into the above categories of shape and gram stain properties include the chlamydias and rickettsias, which are intracellular parasites. *Chlamydia trachomatis* causes a sexually transmitted infection. Rickettsias are transmitted by ticks and cause diseases such as typhus and Rocky Mountain spotted fever.

Some species of bacteria produce endospores (informally called spores). Endospores permit these bacteria to survive drying, lack of nutrients, and harsh conditions such as extreme heat. In favorable conditions, the dormant endospore germinates and produces a bacterial cell. Bacteria that produce endospores include the causes of tetanus, botulism, and anthrax.

Bacteria cause illness in humans in a variety of ways. A particularly potent toxin called **endotoxin** causes life-threatening shock. This toxin is released into tissues when gram-negative bacteria die. Some bacteria produce other types of toxins that interfere with normal physiology. For example, tetanus is caused by the toxin produced by the bacterium *Clostridium tetani*. The tetanus toxin interferes with the ability of muscle cells to relax, resulting in frozen, rigid muscles characteristic of the disease. Other toxins are enzymes that enable the bacteria to spread through tissues and to obtain nutrients.

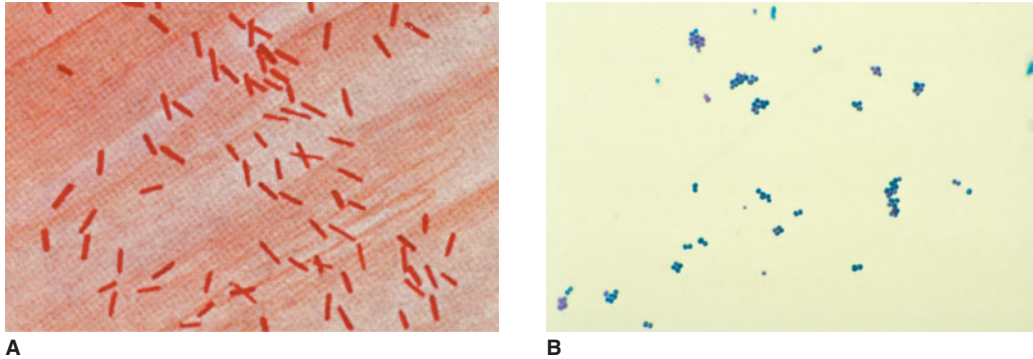


Figure 3-2 ▶ Gram-stained bacteria on a microscope slide. (A) Red rod-shaped cells are *Escherichia coli* (Courtesy of the Centers for Disease Control and Prevention, 1979). (B) Blue-purple cocci are *Staphylococcus aureus*. (© SIU BioMed/Custom Medical Stock Photo)

Protozoa

Protozoa are single-celled eukaryotic (nucleus-containing) microorganisms. They are much larger than bacteria and have complex internal structures, including a nucleus and membranous organelles. Protozoa are found in nearly every habitat, and most do not cause disease; however, they may invade and destroy certain tissues, or they may provoke damaging inflammatory responses. Types of protozoa are described as **amoeboids**, **flagellates**, **ciliates**, and **sporozoans**.

Amoeboids move by means of cell membrane extensions called **pseudopodia** (from Greek words meaning “false feet”). An amoeba of medical concern is *Entamoeba histolytica*, the cause of amoebic dysentery, an intestinal infection acquired from feces-contaminated food or water. Flagellates swim by using one or more whiplike appendages called flagella. Pathogens in this group include *Trichomonas vaginalis*, the cause of trichomoniasis, a sexually transmitted infection, and *Giardia*, the cause of giardiasis, an intestinal infection. Ciliates move by means of numerous short, hairlike projections called **cilia**. There are few pathogens among the ciliates.

Sporozoans are not mobile. Among these, plasmodium is notorious because it causes malaria. Every year, more than 500 million people worldwide become severely ill with malaria and more than 1 million people die as a result. Malaria kills mostly infants, young children, and pregnant women, largely in Africa. Plasmodium is transmitted via the bites of infected mosquitoes.

Fungi

Fungi are single-celled or multicelled organisms with cell walls that contain a polysaccharide called **chitin**. Fungi use specialized filaments called **mycelia** to absorb nutrients from their surroundings. They also have reproductive structures bearing **spores**, which are known allergens.

Fungal infections are known as **mycoses**. Many mycoses are opportunistic infections. Healthy human tissue is relatively resistant to fungal infections but may become susceptible under certain circumstances. For example, fungi can more easily infect damaged tissue than intact healthy tissue. Also, immunocompromised hosts may be unable to resist fungal infections. Fungi cause disease by producing toxins, interfering with normal organ structure or function, or inducing inflammation or allergy. Candidiasis is an opportunistic infection of skin or mucous membranes caused by the yeast *Candida albicans*. *Pneumocystis jirovecii* causes an opportunistic form of pneumonia, one of the diagnostic indicator diseases for AIDS. Other mycoses include a variety of ringworm infections of the skin, hair, and nails.

Helminths

Helminths are parasitic worms. Like other animals, helminths are complex, multicellular, motile organisms. They often have well-developed reproductive systems capable of producing large numbers of offspring. Many helminths have also evolved complex life cycles and strategies for

infecting new hosts. Infections with these organisms are often called **infestations**.

Ascaris infects an estimated 1.4 billion people (Figure 3-3 ►). Ascariasis occurs worldwide, but the largest numbers of cases occur in tropical and subtropical regions. The eggs of the worm are found in soil contaminated by human feces or in uncooked food contaminated by soil. A person becomes infected by ingesting the eggs. The eggs hatch into larvae in the small intestine and mature into adult worms. The female adult worm lays eggs that are then passed into feces. Infections are usually asymptomatic unless infected with a large number of worms. Stool samples are used for diagnosis, and drugs are available for treatment. Prevention includes using toilet facilities, handwashing, safe stool disposal, protecting food from dirt and soil, and thorough washing of produce.

Hookworms such as *Necator americanus* cause anemia and protein malnutrition, afflicting an estimated 740 million people in the developing nations of the tropics (Figure 3-4 ►). The largest numbers of cases occur in sub-Saharan Africa, Latin America, Southeast Asia, and China. Larvae of the hookworm penetrate the skin of the foot, hand, arm, or leg. The larvae travel to the small intestine and mature into adult worms.

Females lay several thousand eggs per day. The eggs are shed in feces and hatch out into larvae in water and from there enter new hosts.



Figure 3-3 ► Ascaris. (Sinclair Stammers/Science Photo Library/Photo Researchers, Inc.)



Figure 3-4 ► *Necator americanus*. The cutting plates around the mouth are used to tear open blood vessels of the host. (© David Scharf/Peter Arnold, Inc.)

There are no specific symptoms or signs of hookworm infection. Stool samples are used for diagnosis, and drugs are available for treatment. Prevention includes not walking barefoot, using toilet facilities, and not using human excrement or raw sewage as fertilizer in agriculture.

Enterobius vermicularis, the pinworm, infects an estimated 200 million people worldwide and is the most common worm infection in the United States (Figure 3-5 ►). The female pinworm migrates to the anus to deposit her eggs on the skin around the anus. She then secretes a substance that incites the host to scratch the area and thus transfer some of the eggs to the fingers. Eggs can also be transferred to cloth, toys, and the bathtub and can survive 2–3 weeks outside of the human body. Humans ingest the eggs, which hatch into larvae in the small intestine. The larvae then migrate to the large intestine and mate. Enterobiasis infections are diagnosed by the Graham sticky-tape method. A piece of transparent tape is placed on the skin around the anus in the morning so it can pick up eggs that were laid earlier. The tape is microscopically examined for the presence of eggs. Treatment includes drugs and thorough washing of clothing and linens to kill eggs. Prevention includes



Figure 3–5 ▶ Adult *Enterobius vermicularis*. (Newscom/Custom Medical Stock Photo)

practicing proper personal hygiene, frequent changing and washing of linens and clothing, keeping nails trimmed, and not scratching the bare anal area.

Prions

A **prion**, short for proteinaceous infectious particle, is an infectious agent composed only of protein. Prions cause a number of diseases in animals and humans known as spongiform encephalopathies, in which the brain becomes

riddled with holes. A well-known prion disease affecting cattle is commonly called mad cow disease. All known prion diseases affect the structure of the brain or other neural tissue by inducing abnormal folding of normal cellular proteins in the brain, leading to brain damage. Prion diseases usually progress rapidly and are currently untreatable and fatal. Human prion diseases include Creutzfeldt-Jakob disease (CJD), familial Creutzfeldt-Jakob disease (fCJD), and kuru. Although CJD is the most common human prion disease, it is still rare and only occurs in about one out of every 1 million people.

Treatment of Infectious Disease

The effective treatment of an infectious disease depends on the type of causative pathogen. Bacterial infections can be treated with a variety of **antibiotics**. Penicillin and related drugs act on the cell wall, and they are especially useful in controlling gram-positive bacteria. Some antibiotics target the bacterial cell membrane, causing lysis. Other antibiotics target the protein synthesis machinery of the cell; this is effective because the ribosomes and enzymes involved in bacterial protein synthesis are sufficiently different from those in human cells. Other antibiotics interfere with bacterial metabolism or with DNA and RNA synthesis. Antibiotic resistance plays an important role in the increased incidence of bacterial infections.

Correct use of antibiotics can prevent the development of **antibiotic resistance**. Resistance arises when bacteria adapt to antibiotics and the adaptation becomes common in the bacterial population, rendering the antibiotics ineffective. Some staphylococcus species, streptococcus species, and enterococcus species, among others, have developed resistance to several antibiotics. Some of these pathogens have earned unique names, such as MRSA (methicillin-resistant *Staphylococcus aureus*) and VRE (vancomycin-resistant enterococci).

The CDC recommends adopting practices to prevent antibiotic resistance. Most important, an antibiotic should be used only for bacterial infections. A number of infections, such as influenza and the common cold, are viral and are not treatable with antibiotics. Some viral ailments closely mimic bacterial infections. For example, it turns out that Group A streptococci cause only

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Advice for Travelers

Traveling out of the country? Have you considered how you will protect yourself and your family from infectious diseases? In a different country, you will be faced with different infectious diseases to which you are unlikely to be immune. Will you need vaccinations or prophylactic medications? The Centers for Disease Control and Prevention in Atlanta, Georgia, maintains a website to advise travelers. Before you book your flight, go to www.cdc.gov for the latest information on infectious diseases at your destination.

Think Critically

1. Vaccines take some time to work. How many days before your trip should you get a vaccine? Explain your answer.
2. A relative from overseas is planning a trip to the United States. What should your relative know about infectious diseases during their stay in the United States?

15% of pharyngitis cases, so only a small proportion of sore throats are really strep throat. Most sore throats are caused by viral infections, some of which closely mimic strep throat because the signs and symptoms include swelling and redness. If antibiotics are used for many of these viral infections, bacterial populations will be more likely to evolve and develop resistance to those antibiotics. The Centers for Disease Control and Prevention has asked physicians to take a throat swab and perform the rapid strep antigen test to confirm the presence of group A streptococci before prescribing antibiotics. If prescribed, the appropriate antibiotic must be selected. Guidelines are shared and updated for physicians so that the most effective types and dosages are used for certain infections. Patients need to follow through on the prescription and use the antibiotics for the entire time prescribed, should not end treatment early, and should not save antibiotics for use in subsequent illnesses.

Viruses do not have the cell walls and cell membranes of bacteria, nor do they have metabolic or protein synthesis machinery. Therefore, viruses are not susceptible to antibiotics. Some antiviral drugs interfere with virus reproduction in the cell by acting as **nucleic acid analogues**, substances that mimic the correct DNA or RNA bases. These analogues are used by cells to manufacture the viral genetic material but do not function as the normal DNA or RNA bases. The analogues cause cells to incorrectly replicate the viruses, reducing their number in the body. Other antiviral drugs interfere with the assembly of new virus particles inside cells or interfere with the attachment of viruses to host cells and thus prevent infection before disease begins.

Antifungal drugs target fungal walls and membranes but can affect human cells as well, leading to toxic side effects. Topical agents are effective for skin infections, such as infections of nails or ringworm, and pose fewer adverse effects. A systemic infection, however, requires systemic treatment, which entails the risk of serious side effects. Systemic treatment requires careful dosing and monitoring for side effects.

Protozoa are treated with drugs that interfere with protein synthesis and metabolism. Certain antibiotics may be used to treat protozoal infections. Helminths are susceptible to drugs that paralyze their muscles or interfere with their metabolism.

Although effective treatments have been discovered and used for many important infections, certain problems remain. One complication is that resistant microorganisms can evolve, rendering existing treatments useless. Another difficulty is that some treatments are accompanied by unacceptable toxic side effects or allergies. For these reasons, preventive measures are the best choice for long-term control of certain diseases.

Emerging and Reemerging Infectious Diseases

In 1963, physician T. Aidan Cockburn wrote in *The Evolution and Eradication of Infectious Diseases*, “We can look forward with confidence to a considerable degree of freedom from infectious diseases at a time not too far in the future. Indeed . . . it seems reasonable to anticipate that within some measurable time . . . all the major infections will have disappeared.” Unfortunately, however, infectious diseases are not only spreading faster, they appear to be emerging more quickly than ever before. Since the 1970s, newly emerging diseases have been identified at the unprecedented rate of one or more per year.

Emerging infectious diseases include outbreaks of previously unknown diseases or known diseases whose incidence in humans has significantly increased in the past two decades. Table 3-3 ► lists emerging infectious diseases. **Reemerging infectious diseases** are known diseases that have reappeared after a significant decline in incidence. Table 3-4 ► lists reemerging infectious diseases. Human demographics and behavior, technology and industry, economic development and land use, international travel and commerce, microbial adaptation and change, breakdown of public health measures, and climate change can play a role in the emergence or reemergence of infectious diseases.

As mentioned, human behavior (failing to vaccinate, for example) can play a role in the reemergence of infectious diseases. Worldwide more than 20 million people are affected each year by measles. In recent years, measles has caused about 164,000 deaths globally. The primary reason for continuing high childhood measles morbidity and mortality is the failure to deliver at least one dose of measles vaccine to all infants. In countries that are able to keep

TABLE 3–3 Examples of Pathogenic Microbes Identified since 1973

Microbe	Type	Disease
Rotavirus	Virus	Infantile diarrhea
Ebola virus	Virus	Acute hemorrhagic fever
<i>Legionella pneumophila</i>	Bacterium	Legionnaires' disease
Human T-lymphotrophic virus I	Virus	T-cell lymphoma/leukemia
Toxin-producing <i>Staphylococcus aureus</i>	Bacterium	Toxic shock syndrome
<i>Escherichia coli</i> O157:H7	Bacterium	Hemorrhagic colitis; hemolytic uremic syndrome
<i>Borrelia burgdorferi</i>	Bacterium	Lyme disease
Human immunodeficiency virus	Virus	Acquired immunodeficiency syndrome
<i>Helicobacter pylori</i>	Bacterium	Peptic ulcer disease
Hepatitis C	Virus	Hepatitis
<i>Vibrio cholerae</i> O139	Bacterium	Cholera
Hanavirus	Virus	Respiratory distress syndrome
<i>Cryptosporidium</i>	Protozoa	Enteric disease
nvCJD	Prion	New variant Creutzfeldt-Jakob disease
H1N1	Virus	Influenza
Nipah	Virus	Severe encephalitis
SARS coronavirus	Virus	Severe acute respiratory syndrome

TABLE 3–4 Reemerging Pathogens

Microbe	Type	Disease
Paramyxovirus	Virus	Mumps
<i>Streptococcus</i> , group A	Bacterium	Strep throat, impetigo
<i>Staphylococcus aureus</i>	Bacterium	Skin and surgical wound infections
<i>Clostridium difficile</i>	Bacterium	Pseudomembranous enterocolitis
Enterovirus 71	Virus	Hand, foot, mouth disease
<i>Coccidioides immitis</i>	Fungus	Valley fever
<i>Mycobacterium tuberculosis</i>	Bacterium	Tuberculosis
<i>Vibrio cholerae</i>	Bacterium	Cholera
<i>Plasmodium</i>	Protozoa	Malaria
Dengue virus	Virus	Dengue hemorrhagic fever

vaccination coverage high, around 95%, measles is very rare. Because immunization controls most serious infectious diseases in the United States, many parents no longer fear the vaccine-preventable diseases. This can expose their children and others to serious infections. For example, in 1991 a group of parents in Philadelphia chose not to immunize their children. Their children became the source of an outbreak of measles that claimed at least eight lives and sickened more than 700 people, mostly children.

Climate changes can alter the breeding ranges of arthropod vectors such as mosquitoes and flies. Malaria, Dengue fever, and yellow fever, all mosquito-borne infections, show sensitivity to climate. Even in areas where malaria is endemic, it occurs with less frequency in higher and cooler elevations.

Lyme disease is an emerging bacterial disease transmitted by deer ticks. Lyme disease became prominent in the northeastern United States after much of the area's agricultural land reverted to forest and deer populations exploded. Then as urban centers grew, human and deer populations inevitably came in contact with more frequency, giving the Lyme disease ticks ample opportunity to attach to humans and their pets.

Emerging antimicrobial resistance demonstrates the potential of microbial adaptation. XDR-TB is the abbreviation for extensively drug-resistant tuberculosis (TB). One in three people in the world is infected with dormant TB bacteria; only when the bacteria become active do people become ill with TB. Bacteria become active as a result of anything that reduces the person's immunity, such as HIV/AIDS, advancing age, or some medical conditions. TB can usually be treated with a course of four standard, or first-line, anti-TB drugs. If these drugs are misused, underused, or mismanaged, multi-drug-resistant TB (MDR-TB) can develop. MDR-TB takes longer to treat with second-line drugs, which are more expensive and have more side effects. XDR-TB can develop when these second-line drugs are also misused or mismanaged and therefore also become ineffective. Because XDR-TB is resistant to first- and second-line drugs, treatment options are seriously limited. It is therefore vital that TB control is managed properly. Multi-drug-resistant strains of enterococcus,

staphylococcus, streptococcus, HIV, and plasmodium are growing global threats.

International travel aids in the emergence of infectious disease. Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by a coronavirus, called SARS-associated coronavirus (SARS-CoV), first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak was contained.

Common Vaccine-Preventable Childhood Infectious Diseases

Vaccine-preventable childhood infectious disease levels are at or near record lows in the United States. The global picture is very different. Every year 1.4 million children worldwide die from vaccine-preventable diseases before they reach age 5.

Measles is a highly contagious disease caused by the rubeola virus. The rubeola virus is spread by respiratory droplets or airborne transmission. Early signs and symptoms include fever, cough, runny nose, and fatigue, followed by a rash that usually begins on the head and spreads to cover the body (Figure 3-6 ►). Grayish spots, called Koplik spots, often develop inside the mouth before the rash appears. Diagnosis is based on history of exposure, Koplik spots, and rash. There is no cure for measles, and it usually runs its course in 7–10 days. Treatment is supportive and may include pain relievers and fever reducers. Measles is part of the MMR (measles, mumps, rubella) vaccine.

Mumps is caused by the paramyxovirus and is spread by contact with respiratory secretions or saliva or through fomites. Mumps may start with a fever of up to 103°F as well as a headache and loss of appetite. The hallmark of mumps is swelling and pain in the parotid glands, the largest of the salivary glands. Mumps in adolescent and adult males may also result in the development of orchitis, an inflammation of the testicles. Diagnosis is based on history of exposure and signs and symptoms. Treatment is supportive and may include pain relievers and fever reducers. Mumps is part of the MMR vaccine.



Figure 3-6 ▶ Measles rash. (© Lowell Georgia/Science Source/Photo Researchers, Inc.)

Rubella (German measles or three-day measles) is caused by the rubella virus. The rubella virus is highly contagious and is spread by respiratory droplets, by airborne transmission, and can also be transmitted from pregnant women to their fetus. When rubella occurs in a pregnant woman, it may cause congenital rubella syndrome, with potentially devastating consequences for the developing fetus. Many people with rubella have few or no signs or symptoms. Some rubella patients develop a rash that appears as either pink or light red spots, which may merge to form evenly colored patches. Other signs and symptoms of rubella, which are more common in teens and adults, may include headache; loss of appetite; mild conjunctivitis (inflammation of the lining of the eyelids and eyeballs); a stuffy or runny nose; swollen lymph nodes in other parts of the body; and pain and swelling in the joints (especially in young women). Diagnosis is based on history of exposure, signs and symptoms, and throat culture for the rubella virus. Treatment is supportive and may include pain relievers and fever reducers. Rubella is part of the MMR vaccine.

Whooping cough is a highly contagious bacterial infection caused by *Bordetella pertussis*. The bacteria are spread by contact with respiratory droplets. The first signs and symptoms

of whooping cough include runny nose, sneezing, mild cough, and low-grade fever. After 1–2 weeks, the cough develops into coughing spells that end with a whooping sound when the patient breathes in. Diagnosis is based on signs and symptoms and bacterial cultures of the nose and throat. Antibiotics are used for treatment. Pertussis is part of the diphtheria, tetanus, pertussis vaccine.

Diphtheria is a highly contagious bacterial disease caused by *Corynebacterium diphtheriae*, which is primarily spread by respiratory droplets; transmission by fomites is rare. Early signs and symptoms include low-grade fever and a sore throat. The bacteria produce a toxin that can cause a thick coating in the nose, throat, or airway that may hinder breathing and swallowing. In the bloodstream the toxin can cause damage to the heart, kidneys, and nervous system. Up to 50% of patients who do not get treatment die. Diagnosis is based on a throat culture. Treatment includes antibiotics and antitoxin. Diphtheria is part of the diphtheria, tetanus, pertussis vaccine.

Tetanus is a bacterial infection caused by *Clostridium tetani*. The bacteria are found in contaminated soil and animal excrement and enter the body via wounds. Once the bacteria are in the body, they produce a toxin that affects the nervous system, causing stiff neck, lock jaw, muscle spasms, and difficulty swallowing. Diagnosis is based on history of exposure, signs, and symptoms. Treatment includes antibiotics and injection of tetanus immunoglobulin to neutralize the tetanus toxin. Tetanus is part of the diphtheria, tetanus, pertussis vaccine.

Chickenpox is a contagious viral infection caused by the varicella zoster virus. There are an estimated 60 million cases worldwide each year. The virus is spread by direct contact, droplet transmission, and airborne transmission. Symptoms begin with a runny or stuffy nose, sneezing, fever, and a cough. A few days later an itchy rash appears, usually on the chest and face (Figure 3-7 ▶). At first, the rash looks like pinkish dots that quickly develop a small blister on top. After about 24–48 hours, the fluid in the blisters gets cloudy and the blisters begin to crust over. Chickenpox blisters show up in waves, so after some begin to crust over, a new group of spots may appear. A person is contagious from up to



Figure 3–7 ► Chickenpox rash. (Centers for Disease Control and Prevention [CDC]/Ann Cain)

48 hours before the initial rash occurs until all blisters have burst and crusted over. Diagnosis is based on history of exposure and the rash. Treatment is supportive and can include treatments to control scratching (corn starch dusting, calamine lotion, and baking soda baths), pain relievers, and fever reducers. A vaccine is available for varicella zoster.

Haemophilus influenzae type b (Hib) is a bacterium that causes diseases including meningitis and pneumonia. Each year an estimated 8 million cases occur, causing 371,000 deaths among young children. The bacterium lives in the human respiratory tract and can be recovered from the nasal and throat passages of up to 90% of all healthy individuals. Hib disease is spread by respiratory droplets, and signs and symptoms include cough, fever, chills, lack of appetite, extreme sleepiness, severe headache, and stiff neck or back. More serious signs are mental confusion, convulsions, shock, and coma. Diagnosis is based on signs and symptoms, lumbar puncture, and bacterial culture. Antibiotics are used for treatment, and there is a vaccine available for Hib. Since the vaccine was introduced in 1990, the incidence of Hib infection among infants and children has dropped 99%, to 1 per 100,000.

Poliomyelitis is caused by the polio virus. Transmission of the virus occurs either by person-to-person contact or by contact with infectious saliva or feces or with contaminated sewage or water. Polio is asymptomatic in approximately 95% of cases. In the cases in which there are symptoms, the illness appears in two forms: nonparalytic polio and paralytic polio. Patients with nonparalytic polio do not develop paralysis. Signs and symptoms can include sore throat, fever, nausea, vomiting, and constipation. Nonparalytic aseptic meningitis is another type of nonparalytic polio. In addition to the flulike signs and symptoms just mentioned, it causes stiffness of the neck, back, or legs. Paralytic polio occurs in 0.1–2% of polio cases. Paralytic polio usually begins with fever; other symptoms, including headache, neck and back stiffness, and constipation, generally appear a few days later. Acute flaccid paralysis, which causes the limbs to appear loose and floppy, often comes on suddenly and usually affects only one side; if both sides are affected, typically one side is worse than the other. Diagnosis is based on history of exposure, signs and symptoms, isolation of the virus from the throat or feces, and lumbar puncture if the nervous system is involved. Treatment is supportive and may include pain relief. A vaccine is available for polio.

Streptococcus pneumoniae is a bacterium that causes diseases including meningitis and upper and lower respiratory disease. Worldwide each year *S. pneumoniae* is estimated to kill approximately 1 million children under age 5. *S. pneumoniae* is present in the upper respiratory tract of about half the population and is transmitted by respiratory droplets. Signs and symptoms may include fever, chills, headache, ear pain, cough, chest pain, disorientation, shortness of breath, and occasionally stiff neck. Diagnosis is based on bacterial culture of body fluids. Antibiotics are used for treatment, although antibiotic resistance is a problem. There is a vaccine available for *S. pneumoniae*.

Resources

Centers for Disease Control and Prevention: www.cdc.gov
 Occupational Safety and Health Administration: www.osha.org
 National Institute of Allergy and Infectious Disease: www.niaid.nih.gov
 World Health Organization: www.who.org

Diseases at a Glance

Pathogens

Pathogen	Disease	Signs and Symptoms
<i>Ascaris</i>	Ascariasis	Asymptomatic except with heavy infestation
<i>Necator americanus</i>	Anemia and protein malnutrition	Asymptomatic
<i>Enterobius vermicularis</i>	Enterobiasis	Itching
Rubeola virus	Measles	Fever, cough, runny nose, fatigue, Koplik spots, rash
Paramyxovirus	Mumps	Fever, headache, loss of appetite, swelling and pain in parotid glands
Rubella virus	Rubella or German measles	May be asymptomatic; rash; other symptoms in teens and adults may include headache, loss of appetite, mild conjunctivitis, a stuffy or runny nose, swollen lymph nodes in other parts of the body, and pain and swelling in the joints
<i>Bordetella pertussis</i>	Whooping cough	Runny nose, sneezing, low-grade fever, coughing spells with whooping sound when breathing in
<i>Corynebacterium diphtheriae</i>	Diphtheria	Low-grade fever; sore throat; coating in the nose, throat, or airway
<i>Clostridium tetani</i>	Tetanus	Stiff neck, lock jaw, muscle spasms, and difficulty swallowing
Varicella virus	Chickenpox	Stuffy nose, sneezing, fever, cough, rash

Diagnosis	Treatment	Prevention
Stool sample	Medication to paralyze helminth muscles or interfere with their metabolism	Use of toilet facilities, handwashing, safe stool disposal, protection of food from dirt and soil, thorough washing of produce
Stool sample	Medication to paralyze helminth muscles or interfere with their metabolism	Not walking barefoot, use of toilet facilities, not using human excrement or raw sewage as fertilizer in agriculture
Graham sticky-tape method	Medication to paralyze helminth muscles or interfere with their metabolism	Personal hygiene, frequent changing and washing of linens and clothing, keeping nails trimmed, not scratching the bare anal area
History of exposure, Koplik spots, rash	Supportive pain relievers, fever reducers	Vaccine
History of exposure, signs and symptoms	Supportive pain relievers, fever reducers	Vaccine
History of exposure, signs and symptoms, throat culture	Supportive pain relievers, fever reducers	Vaccine
Signs and symptoms, bacterial culture of nose and throat	Antibiotics	Vaccine
Throat culture	Antibiotics and antitoxin	Vaccine
History of exposure, signs and symptoms	Antibiotics and tetanus immunoglobulin	Vaccine
History of exposure, rash	Supportive to control itching, pain relievers, fever reducers	Vaccine

Pathogen	Disease	Signs and Symptoms
<i>Haemophilus influenzae</i> type b	Meningitis and pneumonia	Cough, fever, chills, lack of appetite, extreme sleepiness, severe headache, and stiff neck or back. More serious signs are mental confusion, convulsions, shock, and coma
Polio virus	Poliomyelitis	Nonparalytic polio: sore throat, fever, nausea, vomiting, and constipation. Nonparalytic aseptic meningitis: sore throat; fever; nausea, vomiting, and constipation; stiffness of neck, back, or legs. Paralytic polio: fever, headache, neck and back stiffness, constipation, acute flaccid paralysis
<i>Streptococcus pneumoniae</i>	Meningitis and lower respiratory diseases	Fever, chills, headache, ear pain, cough, chest pain, disorientation, shortness of breath, and occasionally stiff neck

Diagnosis	Treatment	Prevention
Signs and symptoms, lumbar puncture, bacterial culture	Antibiotics	Vaccine
History of exposure, signs and symptoms, isolation of the virus from the throat or feces, and lumbar puncture if the nervous system is involved	Supportive pain relief	Vaccine
Culture of body fluids	Antibiotics	Vaccine

Interactive Exercises

Cases for Critical Thinking

- Based on what you learned about transmission and control of infectious diseases, compare how one would approach the control of influenza with the control of malaria. Explain which methods would be useful for each disease.
- Explain why antibiotics are ineffective against viral infections. What problems can arise when viral infections are treated with antibiotics?
- Explain why vaccination is a particularly effective method for controlling infectious disease.
- About a week or two ago, Joe, a 3-year-old boy, had a runny nose, a mild cough, and a low fever. Joe is now having coughing spells and he is having a difficult time inhaling during these coughing spells. What is your diagnosis? How is this transmitted? What treatment is available? Is a vaccine available?
- Mason, a 5-year-old boy, had a runny nose, fever, and cough after attending a birthday party. A few days later a rash appeared on his chest and face. The rash began as pinkish dots but quickly developed a small blister on top. The blisters are appearing in waves. What is your diagnosis? How is this transmitted? What treatment is available? Is a vaccine available?
- Marion, a 3-year-old girl, has a thick coating in her throat that hinders her breathing and swallowing. What is your diagnosis? How can this diagnosis be confirmed? What treatment is available?

Multiple Choice

- A rigid _____ surrounds and protects bacterial cells.
 - plasma membrane
 - cell membrane
 - capsid
 - cell wall
- These protein coats contain the genetic material of a virus.
 - plasma membrane
 - nucleus
 - capsid
 - envelope
- Bacteria do not possess _____.
 - a plasma membrane
 - DNA
 - RNA
 - a nucleus
- Bacteria reproduce by _____.
 - mitosis
 - meiosis
 - binary fission
 - none of the above
- Single-celled eukaryotic organisms are called _____.
 - bacteria
 - helminths
 - viruses
 - protozoa
- German measles is caused by _____.
 - Bordetella pertussis*
 - rubeola virus
 - rubella virus
 - varicella zoster virus
- Whooping cough is caused by _____.
 - Bordetella pertussis*
 - rubeola virus
 - rubella virus
 - varicella zoster virus

8. The cell wall of a fungus contains _____.
 - a. lipids
 - b. chitin
 - c. RNA
 - d. protein
9. The most common worm infection in the United States is _____.
 - a. *Enterobius vermicularis*
 - b. lymphatic filariasis
 - c. ascariasis
 - d. schistosomiasis
10. Which of the following is *not* an example of contact transmission?
 - a. kissing
 - b. touching
 - c. sexual contact
 - d. a needlestick

True or False

- _____ 1. Infectious diseases are not a major cause of death and disability in the world today.
- _____ 2. Rabies is a communicable disease.
- _____ 3. Antibiotics are effective against viruses.
- _____ 4. The respiratory system is the most frequently used portal of entry.
- _____ 5. Ascariasis is the most common type of roundworm infection in humans.
- _____ 6. More than 90% of deaths from infectious diseases worldwide are caused by a few diseases.
- _____ 7. Prions are composed of protein and nucleic acid.
- _____ 8. Handwashing is the single most important means of preventing the spread of nosocomial infections.
- _____ 9. Antibiotics are effective treatments for helminth infestations.
- _____ 10. Chickenpox is transmitted by the parenteral route.

Fill-Ins

1. Microorganisms in and on our bodies make up our _____.
2. _____ diseases are known diseases that have reappeared after a significant decline in incidence.
3. Measles is caused by the _____ virus.
4. _____ infections are acquired in a hospital.
5. In _____ transmission, infectious diseases can be transmitted directly from an infected human to a susceptible human.
6. The bacterial _____ lies inside the cell wall.
7. _____ are single-celled prokaryotic organisms.
8. _____ are infectious agents composed only of protein.
9. Mumps is caused by the _____.
10. Chickenpox is caused by the _____ virus.

Chapter 4

Cancer

Learning Objectives

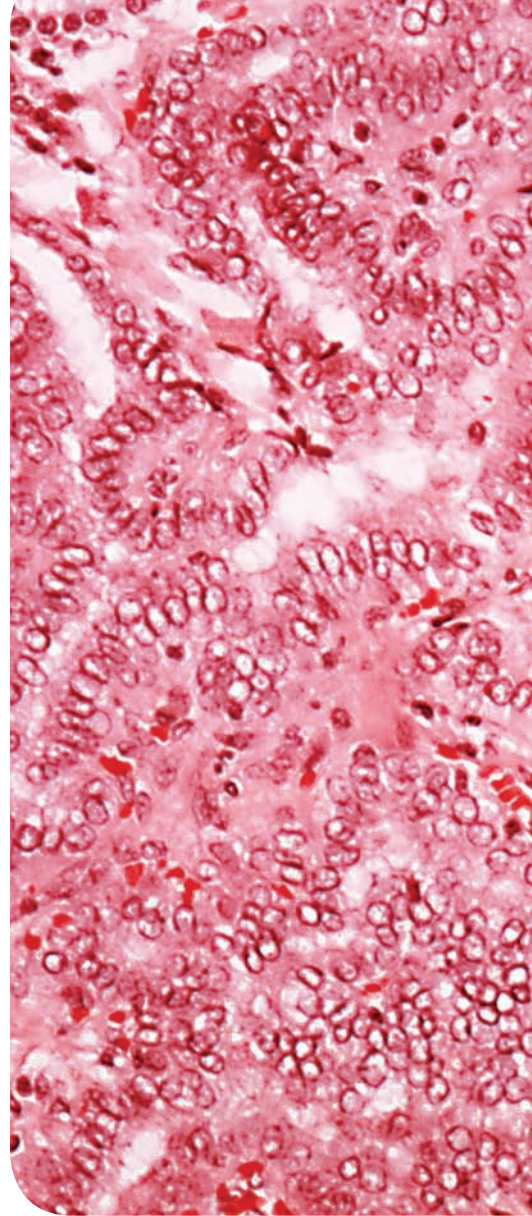
After studying this chapter, you should be able to

- Define basic cancer terminology
- Compare benign and malignant tumors
- Explain how benign and malignant tumors are named
- Identify the known risk factors for cancer
- Describe the etiology of cancer
- Describe how cancer is diagnosed
- Describe how cancer is treated
- Describe how cancer can be prevented

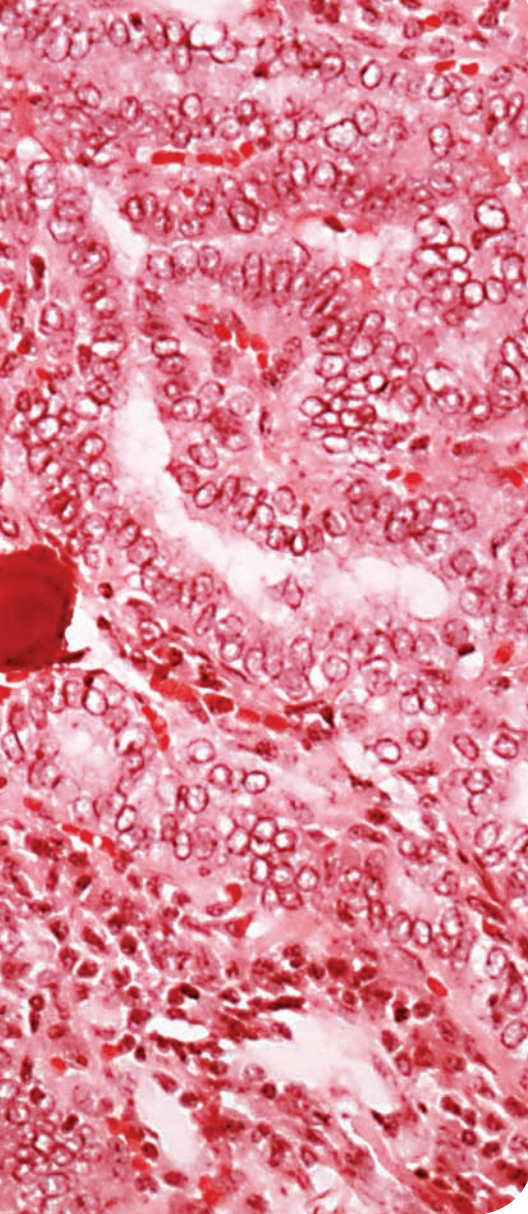
Fact or Fiction?

Cell phones cause cancer.

Fiction: There have been some concerns that radio-frequency energy from cell phones held closely to the head may affect the brain and other tissues. However, according to the National Cancer Institute, to date there is no evidence from studies of cells, animals, or humans that radio-frequency energy can cause cancer.



Histopathology of papillary carcinoma, thyroid. (Courtesy of the Centers for Disease Control and Prevention/ Dr. Edwin P. Ewing, Jr., 1973)



Disease Chronicle

Cancer is an ancient disease. Evidence of cancer was found in Egyptian mummies dating back to 3000 B.C. Our oldest description of cancer (although the word cancer was not used) was discovered in Egypt and dates back to about 3000 B.C. A description of breast cancer was found in the Edwin Smith Papyrus, which is a copy of part of an ancient Egyptian textbook on trauma surgery. The text describes treating eight cases of breast cancer by cauterization with a tool called a fire drill. The writing says "There is no treatment" for the disease. Hippocrates believed that cancer resulted when the four humors or bodily fluids (blood, phlegm, yellow bile, and black bile) fell out of balance with one another, allowing black bile to collect in excess in whichever part of the body the cancer affected.

Introduction

This chapter is a general introduction to cancer. Specific types of cancer are covered in the appropriate system chapter. Cancer is characterized by uncontrolled growth of abnormal cells in the body. These abnormal cells infiltrate normal body tissue and in some cases spread or **metastasize**. Cancer is not just one disease; there are many different types of cancer. Cancer affects the young and old and involves nearly every tissue or organ in the body.

Epidemiology

In the United States one-half of all men and one-third of all women will develop cancer during their lifetimes. Cancer is the second most common cause of death in the United States, exceeded only by heart disease, accounting for nearly one of every four deaths. Approximately 1,660,290 new cancer cases are expected to be diagnosed in the United States in 2013 (Table 4-1 ►). In 2013, about 580,350 Americans are expected to die of cancer (Table 4-2 ►), almost 1,600 people per day. There were an estimated 14.1 million cancer cases diagnosed worldwide in 2012. The number of cancer cases diagnosed worldwide will continue to increase to an estimated 24 million by 2035. (Table 4-3 ►). Cancer is the leading cause of death worldwide; in 2012 cancer killed 8.2 million people (Table 4-4 ►).

TABLE 4-1 Leading Sites of New Cases of Cancer in the United States, 2013

Men	Women
Prostate	Breast
Lung and bronchus	Lung and bronchus
Colon and rectum	Colon and rectum
Urinary bladder	Uterine
Melanoma	Thyroid
Kidney and renal pelvis	Non-Hodgkin's lymphoma

TABLE 4-2 Leading Sites of Cancer Deaths in the United States, 2013

Men	Women
Lung and bronchus	Lung and bronchus
Prostate	Breast
Colon and rectum	Colon and rectum
Pancreas	Pancreas
Liver and intrahepatic bile duct	Ovary
Leukemia	Leukemia

TABLE 4-3 Leading Sites of New Cases of Cancer Worldwide, 2012

Men	Women
Lung and bronchus	Breast
Prostate	Colon and rectum
Colon and rectum	Lung and bronchus
Stomach	Cervix
Liver	Stomach
Esophagus	Uterus

TABLE 4-4 Leading Sites of Cancer Deaths Worldwide, 2012

Men	Women
Lung and bronchus	Breast
Liver	Lung and bronchus
Stomach	Colon and rectum
Colon and rectum	Cervix
Prostate	Stomach
Esophagus	Liver

Tumor Formation

The body is made up of trillions of living cells. These cells grow and divide in a controlled way to produce more cells. When you are young, cells divide faster to allow you to grow. Once you are an adult, most cells divide only to replace worn-out or dying cells or to repair injuries. Sometimes cell division becomes uncontrolled; cells do not die when they should and new cells form when the body does not need them. The result of uncontrolled cell division is an abnormal growth of cells or a **tumor (neoplasm)**. Tumors may be **benign** (not cancer) or **malignant** (cancer). Some cancers do not form solid tumors. These include leukemia (cancer of the blood), most types of lymphoma (cancer of the lymphatic system), and myeloma (cancer of the bone marrow).

Benign tumors are not life-threatening, grow slowly, and remain localized. A benign tumor may grow and enlarge in the area but will not invade surrounding tissue or metastasize to other parts of the body through blood or lymph. Benign tumors have a smooth surface and are symmetrical. Under a microscope the cells of a benign tumor resemble cells of their origin and have a uniform appearance. Benign tumors are encapsulated (covered with a capsule-like material), which makes removal (excision) easier. Benign tumors rarely reoccur after removal.

Malignant tumors are life-threatening, grow rapidly, invade surrounding tissue, and may metastasize to other parts of the body through the blood or lymph. Malignant tumors have a crab-like appearance and an irregular surface (Figure 4-1 ►). Under a microscope the cells of a malignant tumor do not resemble cells of their origin and do not have a uniform appearance (Figure 4-2 ►). Malignant tumors are not encapsulated, making excision more difficult, and tend to reoccur.

Naming Tumors

A benign tumor that projects from an epithelial surface is usually called a **polyp** (Figure 4-3 ►). Most other benign tumors are named by adding the suffix *oma* to the prefix that designates the cell or tissue of origin (Table 4-5 ►). For example, a benign tumor arising from fat tissue is called a lipoma.

Malignant tumors of epithelial origin are named with the prefix that designates the cell or tissue of origin followed by the term **carcinoma**. For example, an adenocarcinoma is a malignant tumor of a gland. These tumors are found in the breast, colon, liver, lung, prostate, skin, and stomach. Carcinomas are more common, grow slower, and metastasize primarily through

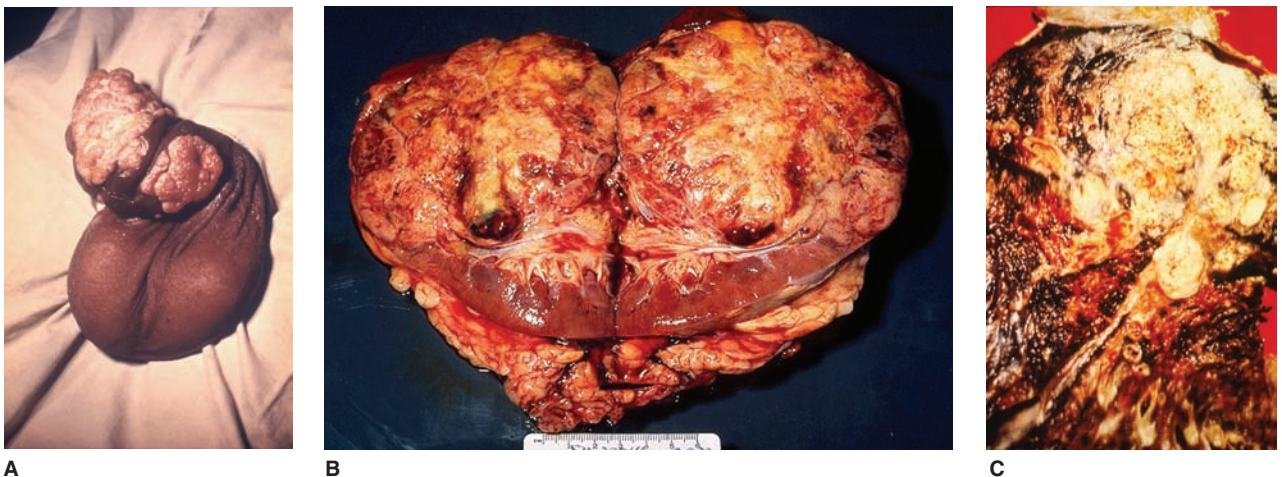


Figure 4-1 ► (A) Penile cancer. (Centers for Disease Control and Prevention/Susan Lindsley; Credit: William R. Smart, San Rafael, California) (B) Kidney cancer (renal cell carcinoma); much of the kidney has been replaced by gray and yellow tumor tissue. (Centers for Disease Control and Prevention/Dr. Edwin P. Ewing, Jr.) (C) Cross section of a human lung. The white area is cancer; the black areas indicate the patient was a smoker. (National Cancer Institute)

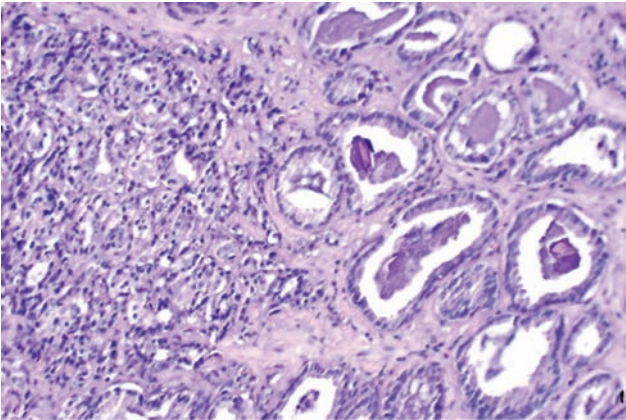


Figure 4–2 ► Microscopic image of prostate cancer. The tissue on the right is somewhat normal; the tissue on the left is abnormal. (National Cancer Institute/Creator: Otis Brawley [Photographer])

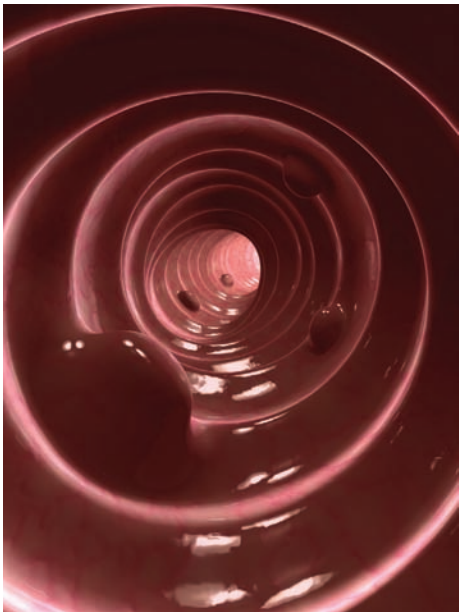


Figure 4–3 ► Colon polyp; a benign epithelial tumor. (Getty Images/Sebastian Kaulitzki)

the lymph. Malignant tumors of the supportive tissue are named with the prefix that designates the cell or tissue of origin followed by the term **sarcoma**. For example, an osteosarcoma is a malignant tumor of bone. These tumors are found in muscle, bone, and cartilage. Sarcomas are less common, grow faster, and metastasize primarily through the blood.

TABLE 4–5 Common Prefixes Used to Name Tumors	
Prefix	Cell or Tissue of Origin
adeno-	gland
angio-	vessels (type not specified)
chondro-	cartilage
fibro-	fibrous tissue
hemangio-	blood vessels
lymphangio-	lymph vessels
lipo-	fat
myo-	muscle
neuro-	nerve
osteo-	bone

Known Risk Factors for Cancer

Research shows that certain risk factors increase the chance that a person will develop cancer.

- *Age.* The most important risk factor for cancer is growing older. About 77% of all cancers are diagnosed in persons 55 years of age and older.
- *Tobacco use.* Tobacco use is strongly linked to an increased risk for many types of cancer. Cigarette smoking causes about 30% of all cancer deaths in the United States.
- *Infections.* Certain infections increase the risk for some types of cancer:
 - *Human papillomavirus* increases the risk for cancers of the cervix, penis, vagina, anus, and vulva.
 - *Hepatitis B* and *hepatitis C* viruses increase the risk for liver cancer.
 - *Epstein-Barr* virus increases the risk for lymphoma and nasopharynx cancer.
 - *Human herpesvirus 8* has been found in nearly all tumors in patients with Kaposi sarcoma.
 - *Human T-lymphotrophic virus-1* has been linked to adult T-cell leukemia.
 - *Helicobacter pylori* increases the risk for gastric cancer.

- **Radiation.** Being exposed to radiation is a known cause of cancer. There are two main types of radiation linked with an increased risk for cancer:
 - Ultraviolet (UV) radiation from sunlight is the main cause of nonmelanoma skin cancers.
 - Ionizing radiation, including medical radiation (x-rays, CT scans, fluoroscopy, nuclear medicine scans), and radon gas in our homes. Ionizing radiation causes leukemia, thyroid cancer, and breast cancer.
- **Immunosuppressive medications.** If a cell has a mutation and is abnormal the immune system should recognize and kill abnormal cells. Both nonspecific and specific immunity are involved in the elimination of abnormal cells. Natural killer cells, part of nonspecific immunity, secrete chemicals that cause pores to form in the membrane of abnormal cells, leading to cell death. Cytotoxic T cells, part of specific immunity, are also involved in the elimination of abnormal cells. Immunosuppressive medications decrease immune function and therefore increase the risk for development of cancer.

Signs and Symptoms of Cancer

The signs and symptoms of cancer will depend on the location of the tumor, its size, and how much it affects the organs or tissues in the area. If a cancer has metastasized, signs or symptoms may appear in different parts of the body. General signs and symptoms of cancer include unexplained weight loss, fever, fatigue, pain, and skin changes (hyperpigmentation, jaundice, erythema, pruritis, excessive hair growth). Unexplained weight loss may be a result of cancer cells competing for nutrients, often at the expense of normal cells' growth and metabolism. Fever is often a systemic response to infection; however, fever is also a common sign of leukemia and lymphoma. Fatigue may be the result of the cancer's effect on the body or the body's response to the cancer. Pain can result from the malignant tumor putting pressure on nerves, bones, or organs. The skin frequently serves as a

marker for underlying internal diseases. Having any of these signs and symptoms does not mean that you have cancer; many other things cause these signs and symptoms, too. Specific cancers have additional signs and symptoms, which will be included in later discussions of specific body systems.

Etiology of Cancer

The etiology of cancer puzzles researchers today nearly as much as it did 100 years ago. Cancer is partially explained by genetics; however, lifestyle and environmental factors also contribute to cancer.

The mechanism of all cancers is uncontrolled cell division, which is the result of alterations (mutation) in genes (pieces of DNA) that play a role in the cell division process. Four types of genes are responsible for the cell division process: oncogenes, tumor suppressor genes, suicide genes, and DNA repair genes. Oncogenes tell cells when to divide and tumor suppressor genes tell cells when not to divide. Mutations that inhibit the function of oncogenes and tumor suppressor genes cause uncontrolled cell division that may result in cancer. Suicide genes control apoptosis (programmed cell death) and tell the cell to kill itself if something goes wrong, and DNA repair genes instruct a cell to repair damaged DNA. Cancer may occur when mutation makes the cell unable to correct DNA damage or unable to commit suicide. The immune system should recognize and destroy these mutated cells, so cancer may also indicate a failure of the immune system.

Mutation in the four genes that are responsible for the cell division process can be inherited or acquired. Mutations inherited from parent to child account for 5–10% of all cancers. Inherited mutations in the tumor suppressor *BRCA1* or *BRCA2* genes increases a woman's risk of developing hereditary breast or ovarian cancers.

In addition to genetics, lifestyle and environmental factors contribute to cancer. The majority of cancers are the result of acquired mutations that are due to environmental and lifestyles factors and therefore are largely preventable. More than 50% of all cancers involve an acquired mutation in the tumor suppressor gene *p53*. Mutations can be caused by **carcinogens**, or

cancer-causing agents or substances. Examples of carcinogens include particular viruses or bacteria, certain chemicals, and radiation.

Diagnosis of Cancer

If a patient has signs and symptoms of cancer, or if a screening test result suggests cancer, a doctor must determine if cancer is the cause. There is no single test that can accurately diagnose cancer. Diagnosis of cancer may include a complete personal and family medical history, physical exam, blood tests, diagnostic imaging, and biopsy.

Blood Tests

Blood tests are used to measure the number of blood cells in circulation and the levels of chemicals, enzymes, proteins, and waste products that are normally found in the blood. The levels of some chemicals normally found in the blood may be either too high or too low as a result of the cancer. Tumor markers are chemicals made by tumor cells that can be detected in blood. Tumor markers are also produced by some normal cells in the body and levels may

be significantly elevated in noncancerous conditions. This limits the potential for tumor marker tests to help in diagnosing cancer. Examples of tumor markers include prostate-specific antigen for prostate cancer and cancer antigen 125 for ovarian cancer.

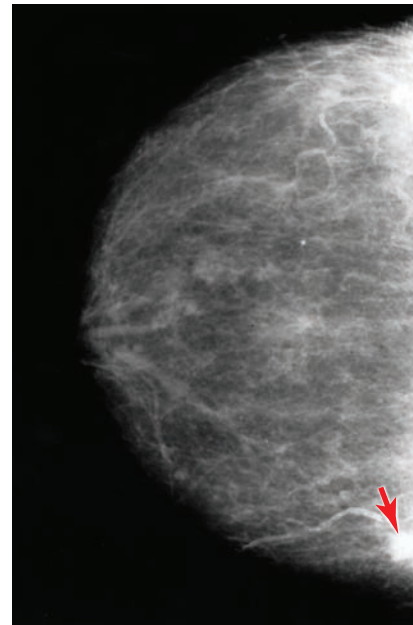
Diagnostic Imaging

A variety of methods are available to view internal organs, to screen for cancer, and to detect tumors.

- *Radiography* is the use of x-rays to form a still or moving picture of the inside of the body. A mammogram is an x-ray photograph of the breast. Potentially malignant tumors show up on a mammogram as small white areas (Figure 4-4 ►).
- *Computed tomography* (CT) is a scanning type of radiography that creates a three-dimensional picture of the inside of the body with an x-ray machine (Figure 4-5 ►). A computer then combines these images into a detailed, cross-sectional view that shows any abnormalities or tumors. Sometimes a contrast medium (a special dye) is injected into a patient's vein to provide better detail.



A



B

Figure 4-4 ► (A) X-ray technician performs a mammogram. (National Cancer Institute/Creator: Alan Hoofring [Illustrator])
(B) Mammogram with cancer indicated by an arrow. (Dr. Dwight Kaufman/National Cancer Institute)



Figure 4-5 ▶ CT scanner. (Shutterstock/Tyler Olson)

- *Magnetic resonance imaging (MRI)* is a type of scanning that uses a magnetic field, not x-rays, to induce tissues to emit radio waves. Different tissues can be distinguished because each emits different signals. With MRI, tumors can then be visualized on a computer screen in cross sections similar to those produced in CT scanning (Figure 4-6 ▶). A contrast medium may be injected into a patient's vein to create a clearer picture.

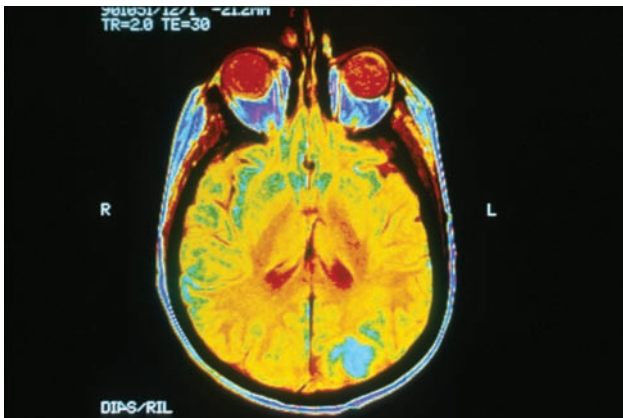


Figure 4-6 ▶ MRI image of brain cancer. The bright blue color indicates where the cancer has metastasized. (National Cancer Institute/Dr. Leon Kaufman, University of California, San Francisco)

- During *ultrasonography*, high-frequency sound waves are reflected off internal tissues to produce an image called a sonogram. Ultrasound does not involve radiation, is easy to use, and is inexpensive.

Biopsy

In most cases a biopsy must be done for a cancer diagnosis. A small tissue sample is removed and the sample is viewed under a microscope. The size and shape of the cells, size and shape of the cell's nucleus, and arrangement of the cells are evaluated.

Grading and Staging Cancer

Part of cancer diagnosis is the grading and staging of the cancer. Grading is helpful in making a prognosis of the disease. Malignant tumors are generally graded on a scale of one to four (Table 4-6 ▶). The higher the number the higher the degree of abnormality. Prostate, breast, and kidney cancer are graded by unique grading scales that reflect the characteristics of cells within these organs.

Malignant tumors are staged to develop a treatment plan and to help predict the prognosis of the disease. Staging is classifying a tumor based on its size and the extent of its spread. In the TNM staging system (Table 4-7 ▶):

- T stands for tumor; it is based on the size of the original (primary) tumor and whether it has grown into nearby tissues.
- N stands for node; it tells whether the cancer has spread to the nearby lymph nodes.
- M stands for metastasis; it tells whether the cancer has spread to distant parts of the body.

TABLE 4-6 Malignant Tumor Grading

Grade	Microscopic description
1	Tumor cells look almost normal
2	Tumor cells look slightly abnormal
3	Tumor cells look abnormal
4	Tumor cells look very abnormal

TABLE 4–7 Cancer Staging

T (Tumor)	
TX	Tumor can't be measured
T0	No evidence of primary tumor
Tis	Cancer cells are only growing in the most superficial layer of tissue, without growing into deeper tissues. This may also be called <i>in situ</i> cancer.
T1–4	Describe the tumor size and/or amount of spread into nearby structures. The higher the T number, the larger the tumor and/or the more it has grown into nearby tissues.
N (nodes)	
NX	Nearby lymph nodes cannot be evaluated
N0	Nearby lymph nodes do not contain cancer
N1–3	Describe the size, location, and/or the number of lymph nodes involved. The higher the N number, the more lymph nodes there are that contain cancer.
M (metastasis)	
MX	Metastasis cannot be evaluated
M0	No distant metastasis was found
M1	Distant metastases were found

Cancer Treatment

The progress of a cancer depends on the particular type of cancer and its location. Without treatment, cancer usually results in death. The ultimate causes of death in cancer patients include secondary infection, organ failure, hemorrhage, and undetermined factors. The treatment plan for cancer depends mainly on the type of cancer and the stage of the disease. The patient's age and general health may also be considered. Most treatment plans include surgery, radiation therapy, or chemotherapy, or a combination of these. Some treatment plans may include hormone therapy or immunotherapy.

Surgery

If possible, malignant tumors are removed via surgery. The tumor and some surrounding tissue are removed. Removing surrounding tissue may help prevent the tumor from recurring. Nearby lymph nodes may also be removed to determine if cancer cells have entered the lymphatic system. Even with surgical removal, the possibility that malignant cells have been left behind may have to be addressed.

Radiation Therapy

About half of all people with cancer receive radiation therapy as part of their cancer treatment; radiation therapy is used to treat just about every type of cancer. Radiation therapy uses high-energy rays to damage DNA of cells, interfering with cell division and growth. Both normal and cancer cell DNA is damaged during radiation therapy. Radiation can be administered in several ways. During external radiation therapy, the radiation comes from a large machine outside the body that aims the beams at precise points on the body to destroy as few normal cells as possible (Figure 4–7 ►). During internal radiation therapy, the radiation is



Figure 4–7 ► Radiation therapy. (National Cancer Institute/Creator: Rhoda Baer [Photographer])

placed inside the body in specific tissue to destroy as few normal cells as possible. The side effects of radiation therapy depend on the dose, type of radiation received, and part of the body treated. Common side effects include hair loss and skin irritation at the treatment site and fatigue. Most side effects are temporary and disappear over time once treatment has ended.

Chemotherapy

About half of cancer patients receive chemotherapy treatment. Chemotherapy is used to treat many kinds of cancer, and many different chemotherapy drugs are used today. Surgery and radiation therapy are considered local treatments; chemotherapy is a systemic treatment. Chemotherapy uses medications that target rapidly dividing cells and, therefore, kills cancer cells and some normal cells. Normal rapidly dividing cells include blood cells, bone marrow cells, cells of hair follicles, and cells lining the digestive tract. Damage to these cells causes the common side effects of anemia, hair loss, nausea, vomiting, and diarrhea. The side effects of chemotherapy are temporary and can often be treated.

Hormone Therapy

Some cancers, such as breast cancer and prostate cancer, need hormones to grow. Surgery may be used to remove the source of the hormone (ovaries, testes). Hormone therapy medications can suppress hormone synthesis or block the action of hormones.

Immunotherapy

Immunotherapy stimulates and strengthens the immune system so it can recognize and kill cancer cells. Nonspecific immunotherapies stimulate the immune system in a very general way. Monoclonal antibodies are synthetic antibodies that are designed to bind to a specific antigen on a cancer cell. Some monoclonal antibodies attach to the cancer cell and signal the immune system to destroy the cancer cell. Other monoclonal antibodies carry drugs or radioactive isotopes directly to cancer cells.

Healthy Aging

Cancer Treatment

When cancer is found early, treatment may be more likely to work. But decisions about how to treat older adults may depend more on their general health and their quality of life than on their actual age. The presence of other health problems and the medications they are taking for these can also affect which cancer treatments they will receive. On the other hand, older adults who are generally healthy do as well with most treatments, including chemotherapy, as their younger counterparts.

Cancer Prevention

At least one-third of all cancers are preventable. Reduce the risk of developing cancer by making healthy lifestyle choices:

- Don't use tobacco. Tobacco use is the single greatest avoidable risk factor for cancer mortality worldwide, causing an estimated 22% of cancer deaths per year.
- Maintain a healthy weight and be physically active. Maintaining a healthy weight may lower your risk for various cancers. Physical activity will help you control your weight and might lower your risk of cancer.
- Eat a healthy diet. Eat plenty of fruits and vegetables and limit fat intake.
- Limit alcohol consumption. If you choose to drink alcohol, do so in moderation—a maximum of one drink per day for women or two drinks per day for men.
- Protect your skin from UV rays. Avoid mid-day sun, use sunscreen, wear protective clothing, and avoid tanning beds.
- Get immunized. Get vaccinated against *hepatitis B* and the *human papillomavirus*.
- Avoid risky behaviors. Practice safe sex. Don't share needles.
- Get recommended cancer screenings. Screening increases the chances of detecting certain cancers early, when they are most likely to be curable.

Promote Your Health

Cancer-Fighting Foods

To reduce your risk of cancer, look no farther than your fridge. Aim for five to nine daily servings of all kinds of fruits and vegetables—especially these superstars:

- Cruciferous vegetables such as broccoli, cauliflower, and cabbage
 - Beans
- Berries
 - Tomatoes
 - Green leafy vegetables such as spinach and kale
 - Grapes
 - Garlic

Prevention PLUS!

Recommended Cancer Screenings

The U.S. Preventative Services Task Force (USPSTF) recommends the following guidelines for cancer screening in adults.

Cancer Screening Tests for Women				
Screening test	Ages 18–39	Ages 40–49	Ages 50–64	Age 65 and older
Breast cancer screening (mammogram)		Discuss with your doctor	Starting at age 50, get screened every 2 years.	Get screened every 2 years through age 74. Age 75 and older ask your doctor if you need to be screened.
Cervical cancer screening (Pap test)	Get a Pap test every 3 years if you are 21 or older and have a cervix. If you are 30 or older, you can get a Pap test and HPV test together every 5 years.	Get a Pap test and HPV test together every 5 years if you have a cervix.	Get a Pap test and HPV test together every 5 years if you have a cervix.	Ask your doctor if you need to get a Pap test.
Colorectal cancer screening (using fecal occult blood testing, sigmoidoscopy, or colonoscopy)			Starting at age 50, get screened for colorectal cancer. Talk to your doctor about which screening test is best for you and how often you need it.	Get screened for colorectal cancer through age 75. Talk to your doctor about which screening test is best for you and how often you need it.

Cancer Screening Tests for Men

Screening test	Ages 18–39	Ages 40–49	Ages 50–64	Age 65 and older
Colorectal cancer screening (using fecal occult blood testing, sigmoidoscopy, or colonoscopy)			Starting at age 50, get screened for colorectal cancer. Talk to your doctor about which screening test is best for you and how often you need it.	Get screened for colorectal cancer through age 75. Talk to your doctor about which screening test is best for you and how often you need it.

Think Critically

1. According to the U.S. Preventative Services Task Force (USPSTF), at what age should women start getting mammograms?
2. According to the USPSTF, at what age should women get yearly mammograms?
3. At what age should men and women begin colorectal cancer screening?

Resources

American Cancer Society, *Cancer Facts & Figures 2013*:

www.cancer.org/research/cancerfactsstatistics/cancerfactsfigures2013/index

American Cancer Society: www.cancer.org

Centers for Disease Control and Prevention: www.cdc.gov

Globocan 2012: http://globocan.iarc.fr/Pages/fact_sheets_population.aspx

National Cancer Institute Cancer Prevention Overview:

www.cancer.gov/cancertopics/pdq/prevention/overview/HealthProfessional

National Cancer Institute: www.cancer.gov

Recommendations of the U.S. Preventative Services Task Force:

www.womenshealth.gov/screening-tests-and-vaccines/screening-tests-for-women/

www.womenshealth.gov/screening-tests-and-vaccines/screening-tests-for-men/index.html

Interactive Exercises

Cases for Critical Thinking

1. Review Tables 4–2 and 4–4. Cervical cancer is number four on the leading sites of cancer deaths worldwide but is not listed in Table 4–2. Please explain this.
2. Malignant tumor cells can often be grown in a lab so researchers can observe their response to experimental drugs. How might this benefit a cancer patient?
3. What can you do to reduce your risk of cancer?
4. Are the mammogram screening recommendations from the USPSTF and the ACS the same?
5. The USPSTF gives breast self-exams a grade of D, which means that the USPSTF recommends against the service. Why?

Multiple Choice

1. A benign tumor arising from fat tissue is called a(n) _____.
 - a. adenoma
 - b. myoma
 - c. osteoma
 - d. lipoma
2. A carcinoma could arise in all the following except _____.
 - a. breast
 - b. colon
 - c. muscle
 - d. skin
3. Which of the following is *not* a general sign or symptom of cancer?
 - a. fatigue
 - b. fever
 - c. hemorrhage
 - d. unexplained weight loss
4. Which of the following genes are *not* responsible for the cell division process?
 - a. cyclins
 - b. oncogenes
 - c. tumor suppressor genes
 - d. DNA repair genes
5. What type of cancer treatment uses high-energy rays to damage DNA of cells interfering with cell division and growth?
 - a. radiation therapy
 - b. chemotherapy
 - c. hormone therapy
 - d. immunotherapy
6. Benign tumors _____.
 - a. are encapsulated
 - b. grow slowly
 - c. remain localized
 - d. all of the above
7. Which of the following is a known risk factor for cancer?
 - a. diet
 - b. lack of physical activity
 - c. infection with certain viruses
 - d. being overweight or obese
8. What scanning type of radiography creates a three-dimensional picture of the inside of the body with an x-ray machine?
 - a. MRI
 - b. CT
 - c. radiography
 - d. ultrasound
9. In a grade 4 tumor, the tumor cells look _____.
 - a. almost normal
 - b. slightly abnormal
 - c. very abnormal
 - d. abnormal
10. The N in the TNM malignant tumor staging stands for _____.
 - a. neoplasm
 - b. node
 - c. nevus
 - d. necrosis

True or False

- _____ 1. The most important risk factor for cancer is tobacco use.
- _____ 2. Some viruses are carcinogens.
- _____ 3. Under a microscope the cells of a benign tumor resemble cells of their origin and have a uniform appearance.
- _____ 4. Mutations inherited from parent to child account for 25% of all cancers.
- _____ 5. At least half of all cancers are preventable.
- _____ 6. In the United States half of all men will develop cancer in their lifetimes.
- _____ 7. There is no single test that can accurately diagnose cancer.
- _____ 8. Benign tumors rarely reoccur after removal.
- _____ 9. The majority of cancers are the result of acquired mutations.
- _____ 10. Benign tumors invade surrounding tissues.

Fill-Ins

1. Osteosarcoma is a malignant tumor of the _____.
2. _____ is the single greatest avoidable risk factor for cancer mortality worldwide.
3. _____ are chemicals made by tumor cells that can be detected in blood.
4. Cancer is the _____ most common cause of death in the United States.
5. Cigarette smoking causes about _____ of all cancer deaths in the United States.
6. A benign tumor that projects from an epithelial surface is usually called a _____.
7. A malignant tumor of a gland is called an _____.
8. _____ uses medications that target rapidly dividing cells and therefore kill cancer cells and some normal cells.
9. Cancer is characterized by _____ growth of abnormal cells in the body.
10. Mutations can be caused by _____, which are cancer-causing agents or substances.

Chapter 5

Heredity and Disease

Learning Objectives

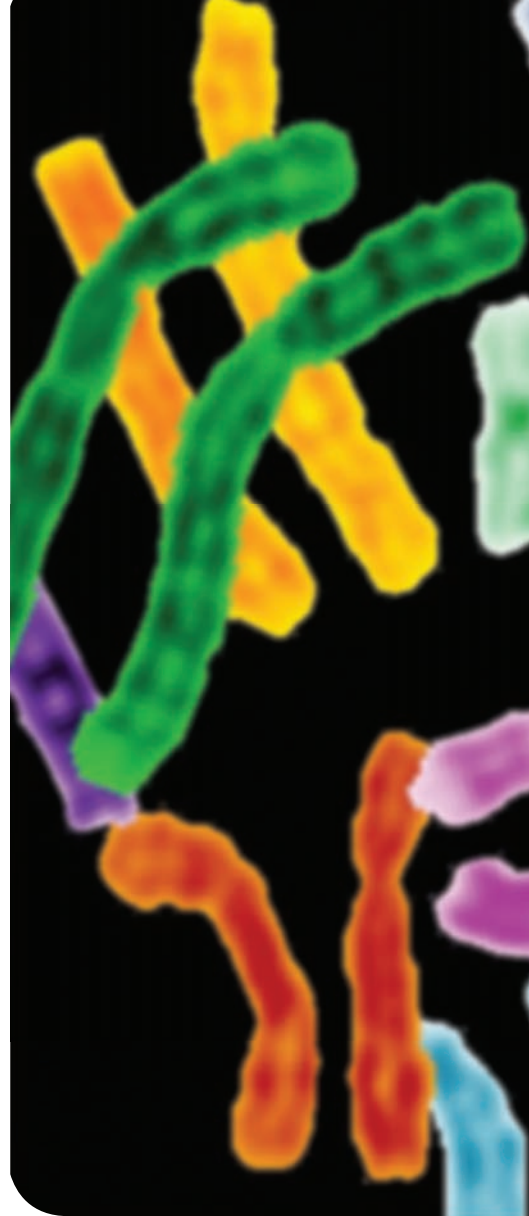
After studying this chapter, you should be able to

- Describe DNA's composition and its role in heredity
- Explain the transmission of hereditary diseases
- Understand how disease is reflected in abnormal karyotype and chromosome structure
- Compare and contrast congenital diseases and genetic disorders
- Understand how gene therapy might be used to treat genetic diseases and disorders

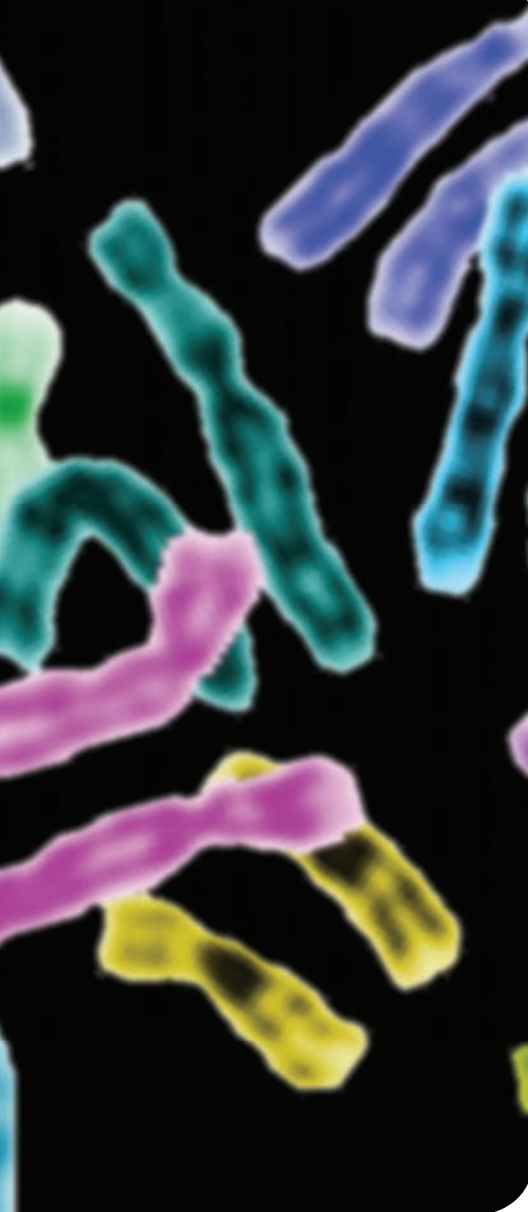
Fact or Fiction?

Blood cholesterol levels are genetically determined.

Fiction: Genes influence the metabolism and synthesis of cholesterol, but diet influences cholesterol levels too.



Human chromosomes. (James Ades, NHGRI)



Disease Chronicle

A Personal Hunt for Huntington's Disease

Dr. George Huntington published observations in 1872 regarding a disease affecting several generations of a family in East Hampton, New York. The inherited, neurodegenerative disorder now bears his name, Huntington's disease. This degenerative disease includes behavioral and personality changes, cognitive changes, depression, and suicidal tendencies.

In 1976 Dr. Nancy Wexler began a 20-year study of a Venezuelan community with a high incidence of Huntington's disease. By 1979 Wexler and colleagues found a genetic marker associated with Huntington's disease, which today helps identify those at risk for the disease.

For Wexler, this discovery was a triumph, for her own mother, grandfather, and three uncles had succumbed to this disease. By 1986 presymptomatic and prenatal genetic testing became available worldwide. Today, preimplantation genetic diagnosis of Huntington's disease allows individuals using *in vitro* fertilization to select a healthy embryo for implantation.

DNA and Chromosomes

DNA Is the Cell's Master Code

DNA, which stands for **deoxyribonucleic acid**, is the chemical blueprint that directs all cell activities. DNA is a double helix similar in shape to a spiral staircase. It is made of a backbone of deoxyribose sugars and phosphates and four chemical bases—adenine (A), thymine (T), guanine (G), and cytosine (C)—which form the “rungs” of the DNA molecule. **Genes** are made from sequences of A, T, G, and C, arranged in different orders and in different lengths (Figure 5-1 ►). DNA has the ability to replicate, and it codes for the synthesis of RNA (ribonucleic acid), which in turn directs protein synthesis.

Chromosomes

Inside the nucleus, DNA is packaged with proteins into **chromosomes**. The chromosomes contain thousands of genes, each of which codes for the synthesis of a particular protein. Normally, each person has 46 chromosomes (23 pairs). Forty-four of the chromosomes (22 pairs) are called **autosomes**, and two (the 23rd pair), the X and Y chromosomes, are called **sex chromosomes**. A male has a combination of one X and one Y chromosome, and a female has two X chromosomes. The complete chromosomal composition of the nucleus is called the **karyotype**. The karyotype can be visualized by extracting the chromosomes from the nucleus and photographing them under a microscope. In this way, abnormalities in number or structure of the chromosomes can be detected (Figure 5-2 ►).

In each ovary or testis are specialized cells with 46 chromosomes in 23 pairs. These cells divide by a process called **meiosis**, during which each of the 23 pairs of chromosomes are separated (Figure 5-3 ►). In this way, meiosis produces gametes, ova or sperm that contain 23 chromosomes each, one chromosome of each pair. When egg and sperm unite during fertilization the karyotype is reestablished at 46. Only the gametes contain 23 chromosomes, one chromosome of each pair, a condition called **haploid**. All other cells of the body are called **somatic cells**, and these contain 46 chromosomes in 23 pairs, a condition called **diploid**. Occasionally

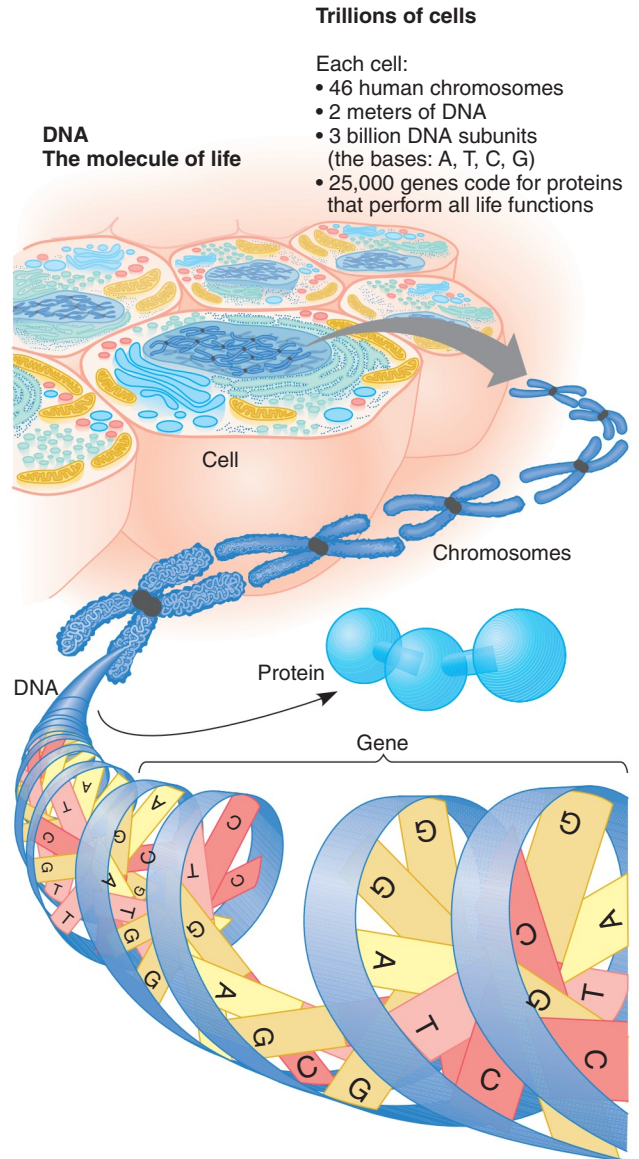


Figure 5-1 ► Each cell nucleus throughout the body contains the genes, DNA, and chromosomes that make up the majority of an individual's genome.

cells receive the wrong number of some chromosomes during meiosis. In many cases, this condition leads to spontaneous abortion shortly following fertilization.

Genes and Inheritance

The genes for a trait occupy a site on a chromosome called a **locus**. Different chromosomes

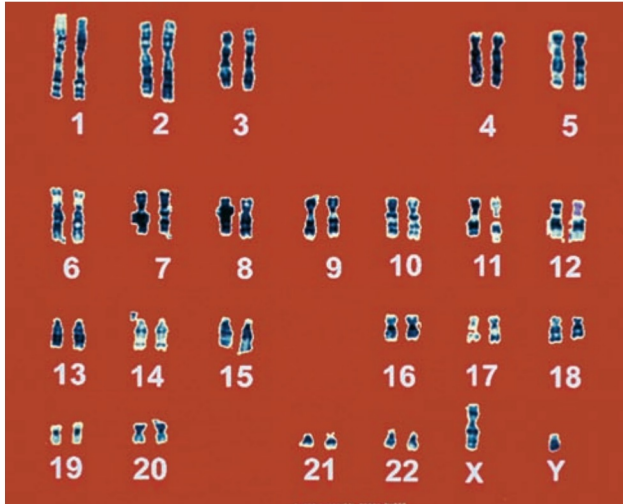


Figure 5-2 ► Human karyotype. (© Custom Medical Stock Photo)

have different genes, and recall that each chromosome occurs as a pair with each chromosome pair bearing the same genes. **Alleles** are alternative forms of a gene, and one of these alleles is located on each of the paired chromosomes. If two of the same allele is inherited, the person is **homozygous** for that trait. If the alleles are different then the person is **heterozygous** for that trait. Some alleles always produce their trait when inherited and are said to be **dominant**. The result of inheriting the dominant allele is usually the same whether a person is homozygous or heterozygous. Other alleles are **recessive**, and only

manifest themselves when the person is homozygous for the trait.

Certain deviations from the basic principles of inheritance have been described. Some alleles are co-dominant, so that when both are inherited, both traits are expressed. An example of co-dominant alleles is found in blood type AB. The allele for the A factor is inherited from one parent and the allele for the B factor from the other, but both alleles are expressed. At times, a dominant allele is not fully expressed, a condition known as reduced penetrance. Various factors modify the expression of genes, including other genes, environmental conditions, and gender. Examples of reduced penetrance include Huntington's disease and Marfan syndrome, in which varying severity of disease occurs when the genes are inherited.

The Human Genome and Disease

The complete set of DNA in a living thing is known as its genome. The sequence of DNA bases comprising the human genome was published in April 2003. Francis Collins, the director of the National Human Genome Research Institute, noted that the genome could be thought of in terms of a book with multiple uses. "It's a history book—a narrative of the journey of our species through time. It's a shop manual, with an incredibly detailed blueprint for building every human cell. And it's a transformative textbook of medicine, with insights that will give health care

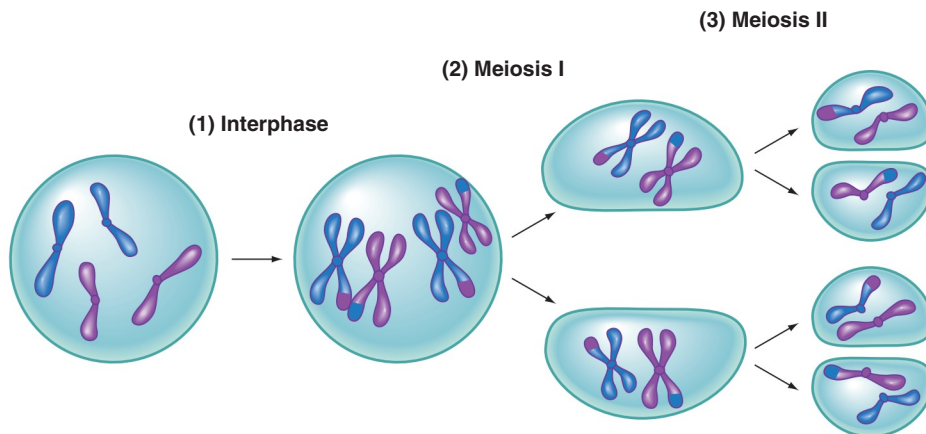


Figure 5-3 ► Meiosis involves two complete divisional operations forming four potential sex cells.

providers immense new powers to treat, prevent, and cure diseases.” The information coded in the genome may transform our understanding of health and disease.

Transmission of Hereditary Diseases

Heredity is the cause of many diseases described throughout this book. Hereditary diseases or disorders often result from a defective gene or genes that produce a defective protein or no protein at all.

Autosomal Dominant Disorders

Some diseases are caused by inheriting a single autosomal dominant allele. A defective dominant allele is usually transmitted by a parent who is heterozygous for the trait. If the other parent is normal, each child has a 50% chance of being affected. This is illustrated in Figure 5-4 ►. These diseases will appear in every generation of the family, with males and females being equally affected. Exceptions to this rule are few. Autosomal dominant disorders include:

- Huntington’s disease, a neurodegenerative disorder

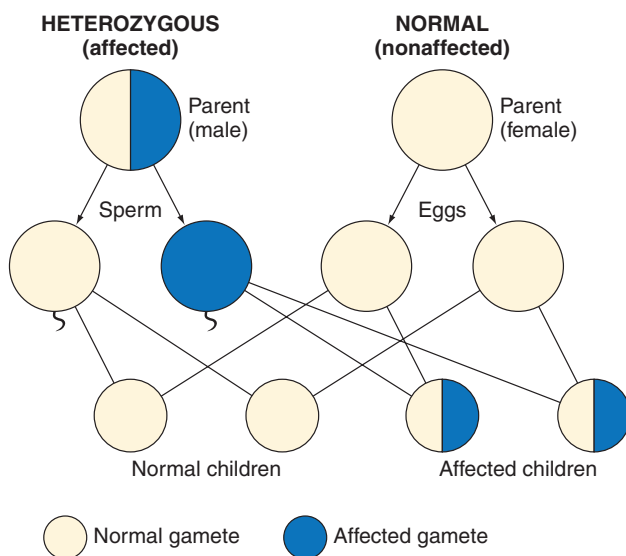


Figure 5-4 ► Transmission of autosomal dominant disorders (50% chance for an affected child).

- Polydactyly, a condition of extra fingers
- Achondroplasia, resulting in achondroplastic dwarfism (Figure 5-5 ►)
- Marfan syndrome, a condition of defective connective tissue, leading to weak blood vessels and joints and vision problems
- Familial hypercholesterolemia, involving inefficient removal of cholesterol from the blood, which leads to deposition of lipids in the walls of arteries and elevated risk for coronary heart disease

Autosomal Recessive Disorders

Other genetic diseases are caused by inherited autosomal recessive alleles. In this case, expression of the disease occurs only when that particular allele is inherited from each parent, making the person homozygous for that trait. Two parents who are carriers of the disease will be heterozygous for the trait but will not have the disease. Each of their children has a 25% chance of inheriting two recessive alleles and the disease. The probability of inheritance is demonstrated in Figure 5-6 ►. The chance for inheriting

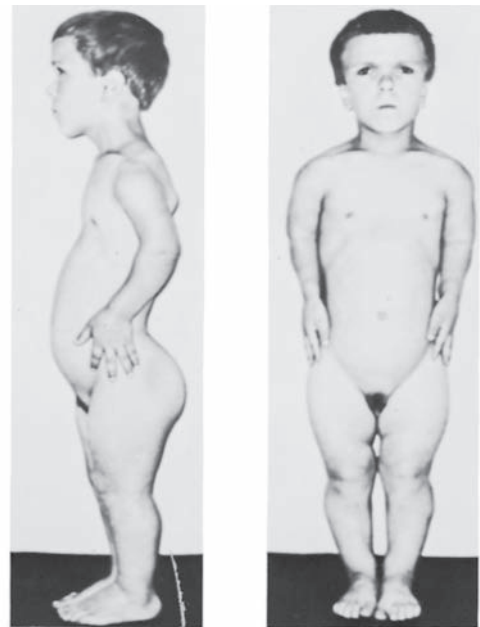


Figure 5-5 ► A 12-year-old achondroplastic dwarf. (Note the disproportion of the limbs to the trunk, the curvature of the spine, and the prominent buttocks.)

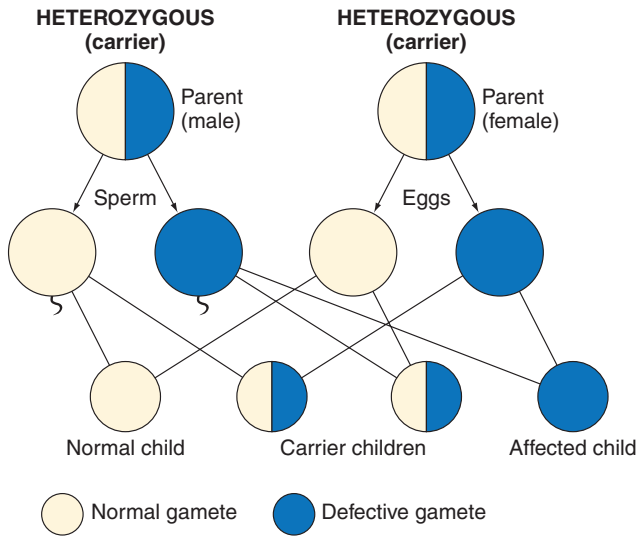


Figure 5-6 ► Transmission of recessive disorders (25% chance for an affected child).

two recessive alleles increases in close intermarriage. Autosomal recessive disorders include:

- Cystic fibrosis, affecting glands that secrete mucus, leading to recurrent, severe respiratory infections and gastrointestinal disorders
- Hemochromatosis, an iron storage disorder
- Phenylketonuria (PKU), an inborn error of metabolism that leads to buildup of toxic products in the brain, leading to developmental problems (Figure 5-7 ►)

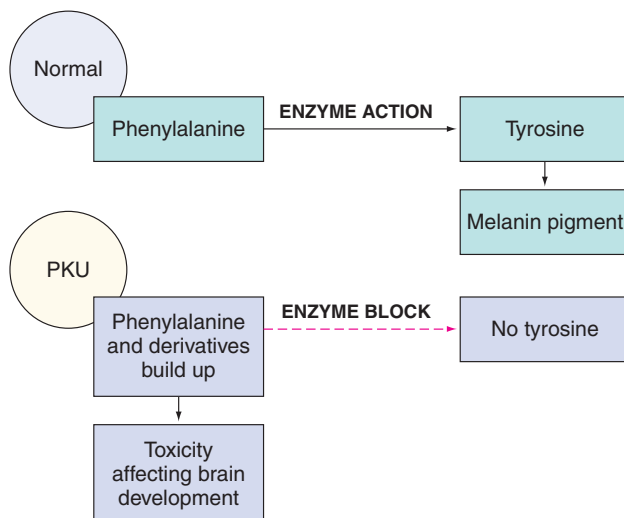


Figure 5-7 ► Enzyme block in phenylketonuria (PKU).

- Galactosemia, an inborn error of sugar metabolism that can lead to impaired mental development and liver damage
- Sickle cell anemia, a disorder in which abnormal hemoglobin causes deformed red blood cells, anemia, and damage to blood vessels
- Tay-Sachs, a rare disease, occurring mostly among families of eastern European Jewish origin, causing neurological damage and death in infants
- Albinism, an absence of the pigment melanin, resulting in colorless white skin, hair, and eyes

Sex-Linked Inheritance

A third type of inheritance is sex-linked, in which the defective allele is located on the X chromosome. The Y chromosome is small and carries few genes. Thus, when a male inherits a defective recessive gene found on the X chromosome, that trait is expressed. A female may be heterozygous for the gene, having a defective recessive allele on one X chromosome but a normal allele on the other X. In that case, the female is a carrier of the disease, but not affected, and she has a 50% chance of transmitting the allele to her sons and daughters. A male transmits the disease only to his daughters. His sons are unaffected because the Y chromosome is normal and fathers contribute only the Y chromosome to males. This inheritance pattern is illustrated in Figure 5-8 ►. Thus, the abnormalities of **sex-linked inheritance** tend to occur more frequently in males, but are transmitted by females. It is far less common for a female to inherit a sex-linked disease because she must inherit two defective X chromosomes. One form of muscular dystrophy, Duchenne's, is an X-linked recessive disease. Sex-linked disorders include:

- Duchenne's muscular dystrophy, abnormal muscle development and wasting
- Color blindness, an inability to see colors
- Hemophilia, several forms of blood-clotting disorders
- Fragile X syndrome, developmental disorder with mental impairment

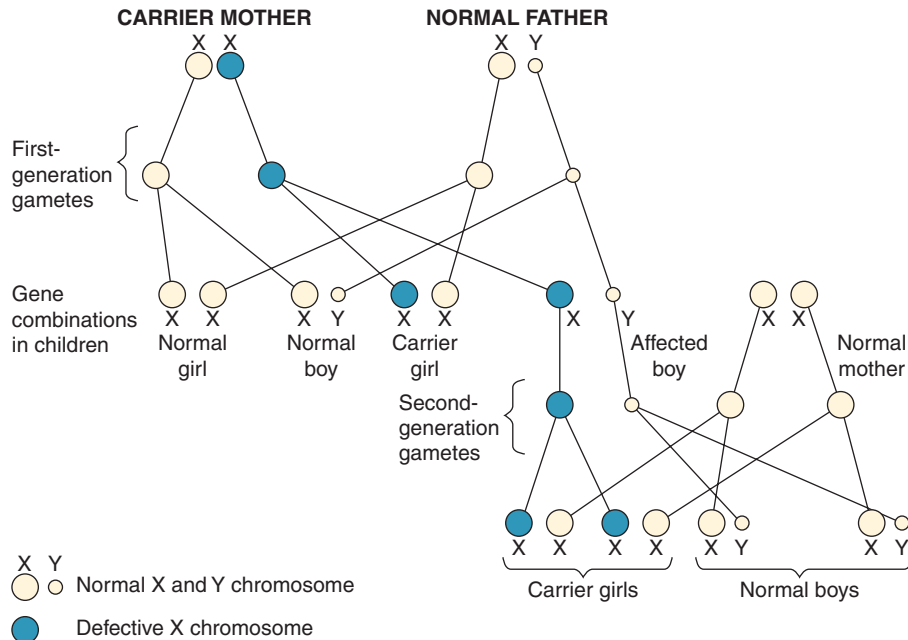


Figure 5-8 ► Transmission of sex-linked disorders.

Familial Diseases

Diseases are described as familial diseases when they consistently appear in families, but the means of inheritance is not understood. Examples of diseases with a higher incidence in certain families are epilepsy, diabetes mellitus, cardiovascular problems, allergies, and familial polyposis. The cause of these diseases does not seem to be a single gene but the effect of several genes working together, a **multifactorial** trait. In fact, some familial diseases may not be inherited at all but instead result from unique environmental conditions or behaviors that are shared by family members.

Abnormal Chromosome Diseases

The hereditary diseases described to this point have resulted from a defective gene. Abnormalities in the chromosomes, either in their number or structure, also cause disorders. On some occasions, chromosomes fail to separate properly during cell division in meiosis. As a result, one gamete will be missing a chromosome while

the other gamete gets an extra chromosome. Fertilization using these gametes will result in an embryo with an abnormal number of chromosomes. The loss of an autosomal chromosome is usually incompatible with life because each autosome contains a large number of essential genes. A fetus affected by this abnormality is generally spontaneously aborted. The loss of a sex chromosome or the presence of an extra one is less serious, but it does cause a number of conditions.

Down Syndrome

Down syndrome is an example of a disorder caused by the presence of an extra autosomal chromosome. In Down syndrome, chromosome 21 is inherited in triplicate, a condition called **trisomy 21**. The extra chromosome results from a nondisjunction, or the failure of the two number 21 chromosomes to separate as the gametes, either the egg or the sperm, are being formed. The prevalence of Down syndrome is about 1 out of 800 and is higher among children born to mothers over age 35.

The Down syndrome child has a characteristic appearance (Figure 5-9 ►). The eyes appear slanted because of an extra fold of skin at the upper, medial corner of the eye. The tongue is coarse and often protrudes, while the nose is short and flat. The child usually has a short stature, and the sex organs are underdeveloped. A straight crease extends across the palm of the hand, and the little finger is often shorter than normal.

A child with Down syndrome may have a shortened lifespan because of complications that accompany the condition, such as congenital heart disease. In addition, there is a greater susceptibility to respiratory tract infections, especially pneumonia, and a higher rate of acute leukemia among those with Down syndrome. An individual with Down syndrome may live more than 55 years, while in 1910 their life expectancy was only 9 years.

The Down syndrome child is always mentally impaired to some degree. The child can be taught simple tasks and is generally very affectionate. Today Down syndrome individuals receive special education and work opportunities, enabling them to be active in their communities.



Figure 5-9 ► Boy with Down syndrome.

Sex Anomalies

Turner's Syndrome

Turner's syndrome results from the presence of only one X chromosome. With one X chromosome, a person with Turner's syndrome appears to be female, but the ovaries do not develop. Thus, there is no ovulation or menstruation, and the person is sterile. The mammary nipples are widely spaced, the breasts do not develop, and the person is short of stature and has a stocky build. The occurrence for Turner's syndrome is about 1 in 2,500 live births. Major complications include congenital heart disease and coarctation of the aorta. Figure 5-10 ► shows a Turner's syndrome karyotype.

Klinefelter's Syndrome

An extra X chromosome is present in **Klinefelter's syndrome**. The disorder occurs in about 1 in 500 to 1 in 1,000 male births. The person with Klinefelter's appears to be a male but has small testes that fail to mature and produce no sperm. At puberty, female secondary sex characteristics emerge, the breasts enlarge, and female distribution of hair develops. Little facial hair develops, and the general appearance is that of an immature young adult. The person is tall and slender with abnormally long legs. Testosterone therapy may help the person develop the male sexual characteristics.

Hermaphroditism

The number of true **hermaphrodites** who have both testes and ovaries is small. **Pseudohermaphrodites** do develop, and they have either testes or ovaries, usually nonfunctional, but the remainder of the anatomy is mixed. This condition has also been referred to as sex reversal or intersex, in which the chromosomal sex is different from the anatomic sex. Sex reversal occurs during fetal life. The sex glands are neutral during the first few weeks after conception until the testes differentiate at about the sixth week under the influence of the masculinizing hormone testosterone. In the absence of an adequate amount

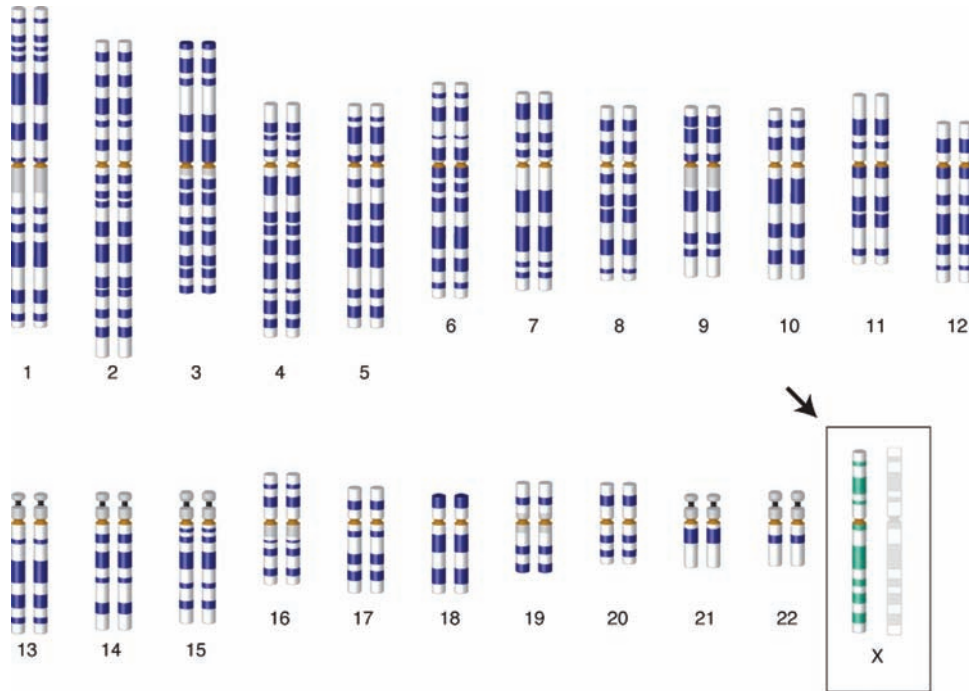


Figure 5-10 ► Karyotype for Turner's syndrome (45, XO). (Darryl Leja, NHGRI)

of this hormone, ovaries develop, and the individual develops anatomically female but remains chromosomally male (XY).

Some cases of pseudohermaphroditism result from excessive production of sex hormones produced by the adrenal cortex or an unexplained insensitivity to hormones. An affected female develops male secondary sexual characteristics at a very early age. The external genitalia of pseudohermaphrodites are ambiguous, resembling those of both males and females.

Treatment may involve surgery, hormonal therapy, and counseling. Hermaphroditism cannot be prevented.

Genetic Counseling and Diagnosis

Diagnosis of Genetic Diseases

Early intervention is critical for prevention and treatment of genetic diseases. In a clinical procedure called **amniocentesis**, a small amount of amniotic fluid is withdrawn after the 14th week

of pregnancy. Fetal cells in the amniotic fluid are removed, the chromosomes are examined, and the amniotic fluid is analyzed for biochemical abnormalities. Test results in amniocentesis are available approximately 2 weeks after the procedure. Amniocentesis can detect approximately 200 genetic diseases before birth.

Chorionic villus sampling involves removing cells from the villi through the cervix. Chorionic villi are projections of the membrane that surrounds the embryo in early pregnancy. Samples may be taken between 8 and 10 weeks of pregnancy. The chromosomes of the cells obtained can be analyzed immediately. Chorionic villus sampling gives information about gender and chromosomes sooner within the pregnancy. This procedure allows time for options, including termination of pregnancy or preparation for a child with special needs.

Gene Therapy for Genetic Diseases

Gene therapy is a procedure that involves identification, manipulation, and transfer of genetic material into a patient to replace or repair

Prevention PLUS!

Huntington's Disease

Huntington's disease is a devastating, dominantly inherited, neurological disorder. If a man and woman are interested in having children, and Huntington's disease affected the man's father, they should be concerned about transmitting the disease to their child.

Think Critically

1. If the man's father had Huntington's and the woman and her parents are normal, explain why the man should be concerned about passing along the disease.
2. Explain how he can know about whether he carries the disease.

defective genes. The genetic material used is compatible with human DNA that may be cultured in a microbe and delivered in a viral package or by injection. Gene therapy is still not a mainstream treatment, but improved techniques and recent clinical trials suggest that some effective treatments of this kind may be available in the coming years.

Congenital Disorders

Congenital disorders are those present at birth or shortly after, not including those caused by genetic or chromosomal abnormalities. Congenital defects usually result from some failure in the development process during the embryonic stage, or in the first 2 months of pregnancy.

Various factors—inadequate oxygen, maternal infection, drugs, malnutrition, and radiation—can interfere with normal development. *Therefore, congenital diseases cannot be transmitted to offspring.* Congenital disorders include:

- Congenital rubella
- Cerebral palsy
- Hydrocephalus
- Spina bifida
- Congenital heart diseases
- Congenital disorders of the intestine
- Cleft lip and cleft palate

The drug thalidomide was introduced in the 1950s and used until 1962 during early pregnancy for morning sickness. The tragic results alerted the public to the danger of harmful drugs for the developing embryo. Some babies who had been exposed to thalidomide within the first 2 months of pregnancy were born without limbs or had flipperlike appendages. The Food and Drug Administration (FDA) banned thalidomide.

Resources

American Society of Human Genetics: www.ashg.org
 American Society of Medical Genetics: www.asmg.org
 Genetics Home Reference: <http://ghr.nlm.nih.gov>
 Medline Plus: www.medlineplus.gov
 National Human Genome Research Institute: www.nhgri.nih.gov
 National Center for Biotechnology Information: www.ncbi.nlm.nih.gov
 National Library of Medicine: www.nlm.nih.gov
 National Marfan Foundation: www.marfan.org

Diseases at a Glance

Heredity*

Disease	Etiology	Signs and Symptoms
Autosomal dominant inheritance		
Achondroplasia	Chromosome 4, autosomal dominant, usually spontaneous	Short arms and legs, normal trunk, dwarfism, megaloccephaly, lordosis; may depend on parent age
Marfan syndrome	Chromosome 15, autosomal dominant	Skeletal malformations, long facial appearance, scoliosis, hypermobile joints, aortic aneurysm, ocular lens defects
Familial hypercholesterolemia	Incomplete autosomal dominant	Atherosclerosis, coronary artery disease
Autosomal recessive inheritance		
Fragile X syndrome	Constricted segment on long arm of X, FMR1 gene mutation	Mental deficiency, large head, flat feet, prominent ears and forehead, macro orchidism
Galactosemia	Autosomal recessive, lack enzyme for lactose digestion	Enlarged liver, ascites, vomiting, diarrhea, cataracts, mentally impaired cerebral palsy
Hemochromatosis	More males; secondary to excess alcohol and anemia	Early—abdominal pain, arthritis; later—fatigue, diabetes, liver damage, reduced sex drive
Phenylketonuria	Chromosome 12, autosomal recessive	Light skin tone, blue eye, mental impairment if not corrected
Tay-Sachs Disease	Mutant Hex-A gene on chromosome 15	Mental impairment

*Many diseases and disorders have a genetic component. This chart lists those diseases and disorders with a known genetic or chromosomal abnormality.

Diagnosis	Treatment	Prevention
Present at birth, DNA tests before birth	None	Family history, genetic counseling
Onset is age 20, detection of protein fibrillin	Depends on affected areas. Drugs to reduce aorta expansion (e.g., beta blocker) or bone surgery	None without family history, genetic screening; one-third are sporadic cases
Onset at birth, high LDLs	Exercise, low-fat diet, statins	None, detect early as possible
DNA sequencing for triplet CGG sequences near FMR1 gene	No special treatment, special education, physical and occupational therapy as for ADHD	None, perhaps counseling if aware; cytogenic review of newborn for FMR1 gene as early detection
High blood galactose levels	Diet control, no lactose in food	Screened at birth
Excess serum ferritin-iron and alkaline phosphatase, DNA test for HFE mutation, liver biopsy	Phlebotomy, blood donation, Nexium or Prilosec	DNA test, genetic screening
Blood and urine levels of phenylalanine	Restricted diet within day of birth	Enzyme assay, strict diet, along with family history
Genetic blood screening	Genetic counseling	Genetic blood screening for parental traits, family history

Disease	Etiology	Signs and Symptoms
Change in chromosomal number		
Down syndrome	Extra chromosome 21 due to nondisjunction	Mentally impaired, rounded face, protruding tongue, short stature
Klinefelter's syndrome	Extra X chromosome (47 total)	Tall and slender, long legs, sparse body hair, weak breast development, usually sterile, male
Turner's syndrome	Missing X chromosome (45 total)	Short stature, female, broad-flat breast, malformed elbows, sterile, hearing problems

Diagnosis	Treatment	Prevention
Observation, chromosomal screen	Supportive, special education	Mother age under 35, prenatal maternal α -fetoprotein, PAPP-A test
Genetic screen, low testosterone, XXY makeup	Testosterone therapy at puberty, counseling, family supported	None
May not be known until puberty, lack physical development	May use growth hormone therapy plus estrogen and other supplements	None

Interactive Exercises

Cases for Critical Thinking

1. What is the reason that Turner's and Klinefelter's syndromes can occur as a result of nondisjunction in either the sperm or the egg but XYY can occur only as a result of nondisjunction in the sperm?
2. Marfan syndrome is an autosomal dominant disease. If a parent has Marfan syndrome, what is the probability that his or her child will have Marfan syndrome?
3. If a mother is a carrier for the X-linked disease hemophilia A, what is the probability that her male child will have hemophilia A? What about her female child?
4. A 36-year-old father of three with a new job thought stress had brought on abdominal pain and joint pain. He had noticed a darkening of his complexion and consulted a doctor, who found excess ferritin levels in his blood. What problem seems evident, and what treatment would help this individual?

Multiple Choice

1. What do polydactyly and achondroplasia have in common?
 - a. Both are autosomal recessive.
 - b. Both are sex-linked.
 - c. Both are congenital defects.
 - d. Both are autosomal dominant traits.
2. Except for sperm and ova, how many chromosomes do human cells each have?
 - a. 23
 - b. 46
 - c. 96
 - d. 21
3. What combination of alleles manifests themselves only when the person is homozygous for the trait?
 - a. recessive
 - b. dominant
 - c. homozygous
 - d. heterozygous
4. Why do sex-linked diseases affect men more than women?
 - a. Men have two X chromosomes.
 - b. Men have two Y chromosomes.
 - c. Men have one X chromosome.
 - d. Men have no Y chromosome.
5. Which of the following is an autosomal dominant disease?
 - a. PKU
 - b. Marfan syndrome
 - c. Hemochromatosis
 - d. Turner's syndrome
6. What type of disorder is galactosemia?
 - a. autosomal dominant
 - b. autosomal recessive
 - c. sex-linked
 - d. congenital
7. If a female is a carrier of a sex-linked disease, what is the chance of transmitting the allele to her children?
 - a. 25%
 - b. 50%
 - c. 75%
 - d. 100%
8. If both parents are carriers of an autosomal recessive disease, what is the chance of their children getting the disease?
 - a. 0%
 - b. 25%
 - c. 50%
 - d. 100%

9. If alleles are different for a trait, how do you describe the genotype for that individual?
 - a. homozygous
 - b. recessive
 - c. heterozygous
 - d. dominant
10. How many autosomal chromosomes are found in each human body cell?
 - a. 22
 - b. 2
 - c. 44
 - d. 46

True or False

- _____ 1. DNA is the master genetic code.
- _____ 2. The incidence of Down syndrome increases with the mother's age.
- _____ 3. Fragile X syndrome is found equally in men and women.
- _____ 4. A patient with Turner's syndrome has an extra sex chromosome.
- _____ 5. Tay-Sachs is an autosomal dominant disease.
- _____ 6. Marfan syndrome is caused by an extra sex chromosome.
- _____ 7. Albinism is a sex-linked disease.
- _____ 8. Homozygous traits tend to be expressed at each generation.
- _____ 9. If one parent is heterozygous for an autosomal dominant disease and the other parent is normal, a child has a 50% chance of getting the disease.
- _____ 10. Duchenne's muscular dystrophy affects more boys than girls.

Fill-Ins

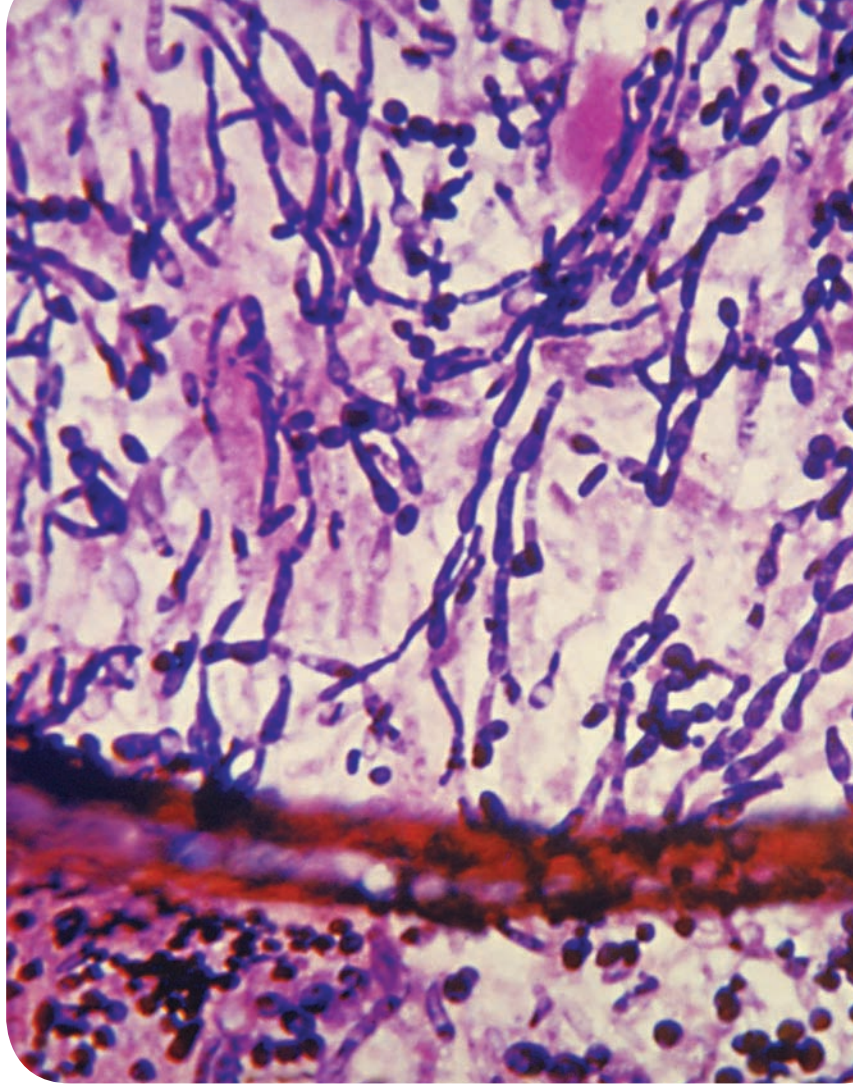
1. _____ diseases are those appearing at birth or shortly after, but they are not caused by genetic or chromosomal abnormalities.
2. _____ have both testes and ovaries.
3. _____ alleles manifest themselves when the person is heterozygous for that trait.
4. _____ is defective in Marfan syndrome.
5. _____ are alternative forms of a gene.
6. _____ is the condition of extra fingers or toes.
7. _____ is the failure of two chromosomes to separate as the gametes are being formed.
8. Sex cells contain _____ chromosomes.
9. A recessive genetic disease affecting metabolism of phenylalanine is _____.
10. Replacement of genetic material by recombinant DNA technology is called _____.

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Part II

Diseases and Disorders of the Systems

Part II presents diseases and disorders of the body's systems. Each chapter reviews the normal structure and function of a body system and then discusses diseases and disorders associated with that system. Signs, symptoms, etiology, diagnosis, treatment, and prevention are described for each.



Chapters

6. Diseases and Disorders of the Cardiovascular System
7. Diseases and Disorders of the Blood
8. Diseases and Disorders of the Respiratory System
9. Diseases and Disorders of the Gastrointestinal System
10. Diseases and Disorders of the Urinary System
11. Diseases and Disorders of the Reproductive System
12. Diseases and Disorders of the Endocrine System
13. Diseases and Disorders of the Nervous System
14. Diseases and Disorders of the Eye and Ear
15. Mental Disorders
16. Diseases and Disorders of the Musculoskeletal System
17. Diseases and Disorders of the Integumentary System

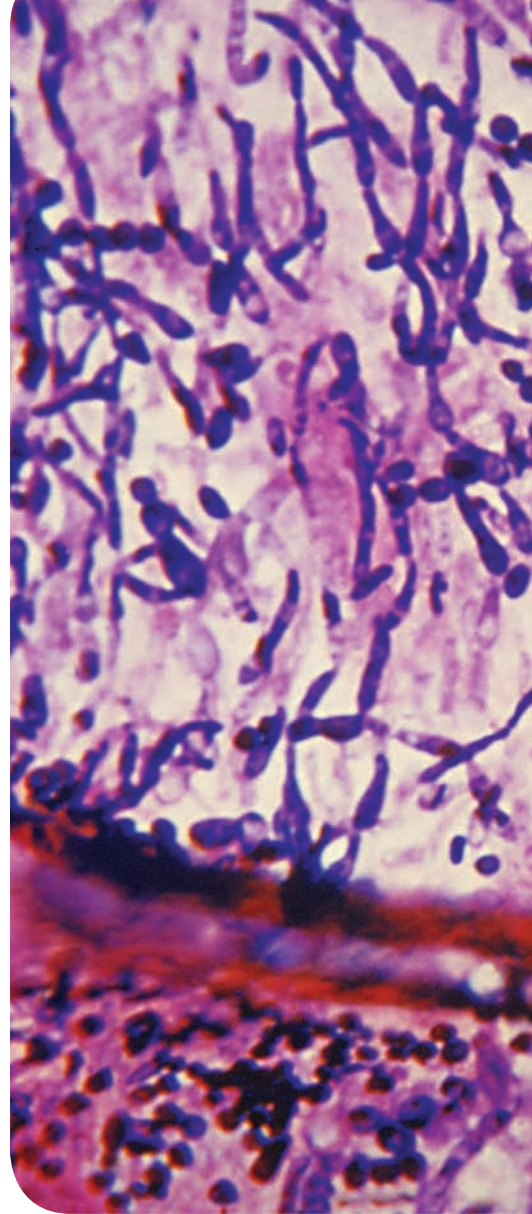
Chapter 6

Diseases and Disorders of the Cardiovascular System

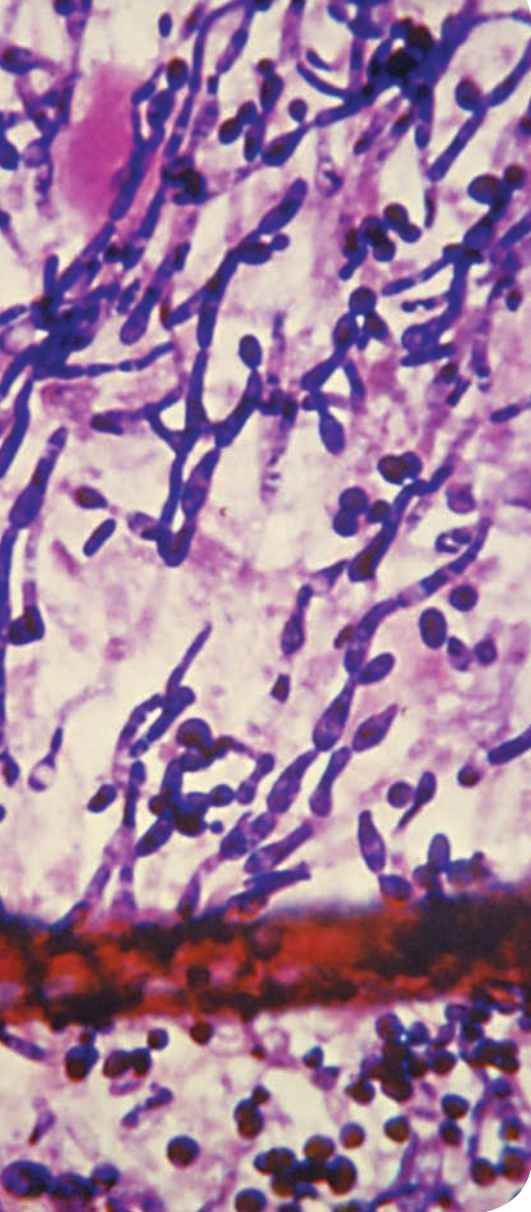
Learning Objectives

After studying this chapter, you should be able to

- Describe the normal structure and function of the heart and blood vessels
- Describe the key characteristics of the diseases of the arterial circulation and heart
- Explain the role of arteriosclerosis and atherosclerosis in cardiovascular disease
- Identify the role of hyperlipidemia in atherosclerosis
- Describe the etiology, signs, and risks associated with arterial hypertension
- Compare and contrast pulmonary hypertension and arterial hypertension
- Describe the role of varicose veins in peripheral vascular disease
- Understand the risks associated with venous thrombosis
- Understand the distinguishing features of heart valve stenosis and heart valve regurgitation
- Explain the different types of atrial and ventricular arrhythmias
- Name the etiologies of shock
- Describe normal fetal circulation
- Describe the epidemiology, symptoms, etiology, diagnosis, and treatment of congenital heart abnormalities
- Review the risks and pathological changes associated with heart disease in older adults



This photomicrograph reveals histopathologic changes indicative of endocarditis caused by the fungus *Candida albicans*. (Courtesy of Centers for Disease Control and Prevention/ Sherry Brinkman, 1963)



Disease Chronicle

Dr. Christiaan Barnard

Dr. Christiaan Barnard performed the first human heart transplant in 1967 in the Union of South Africa. Dr. Barnard performed this famous surgery on a 53-year-old dentist named Louis Washkansky. A 25-year-old auto accident victim named Denise Davall donated her heart to Washkansky. Although the surgery was a technical triumph and a beacon of hope for many with terminal heart disease, Washkansky died 18 days later from infection. Still risky today, heart transplants owe their successes to the generosity of Denise Davall, the courage of Louis Washkansky, and the brilliance of Dr. Barnard, who died of a heart attack in 2001.

Fact or Fiction?

Aspirin therapy reduces the risk of myocardial infarction.

Fact: By minimizing platelet aggregation and clot formation, aspirin therapy reduces the risk of a myocardial infarction.

Anatomy and Physiology Review

The main function of the circulatory system is transport of oxygen, nutrients, waste products, electrolytes, leukocytes, and hormones among the tissues and organs of the body. The circulatory system comprises the heart, blood vessels, and blood. The heart pumps blood, and the blood vessels serve as tubes through which blood flows. The arterial system carries blood from the heart to the tissues, and the veins carry it back to the heart.

Structure and Function of the Heart

The heart is a hollow muscular organ located in the center of the chest. The heart consists of four chambers: a right and left atrium and a right and left ventricle. The atria collect blood from the body and the lungs and pass it to the ventricles. The ventricles eject blood throughout the body and the lungs. The chamber walls consist of cardiac muscle, known as **myocardium**, and their internal lining consists of a smooth, delicate membrane called the **endocardium**. The **pericardium**, a double-layered membrane, encloses the heart within the pericardial cavity (Figure 6-1 ►).

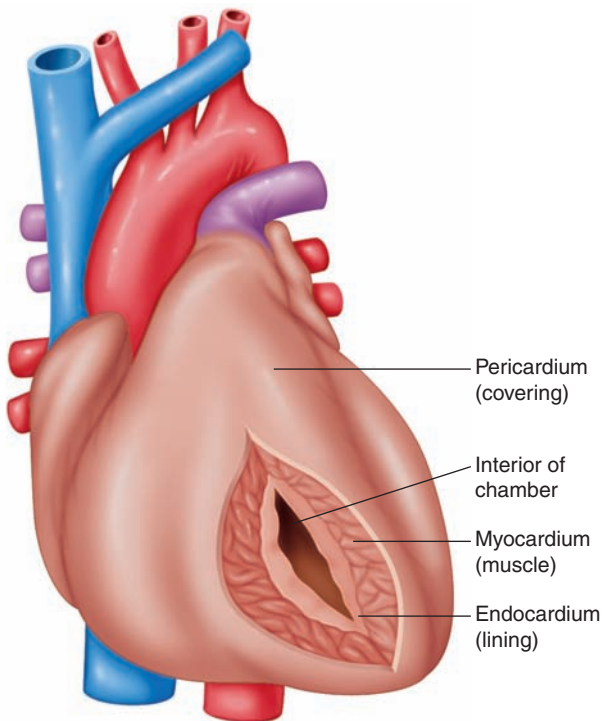


Figure 6-1 ► Heart covering and layer of the heart.

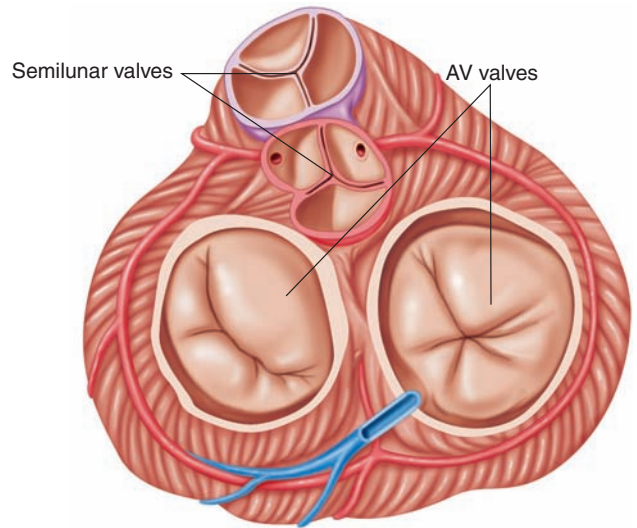


Figure 6-2 ► Heart valves in closed position viewed from the top.

Valves between the atria and the ventricles, the atrioventricular (AV) valves, permit one-way blood flow from the atria to the ventricles. The **mitral valve** between the left atrium and left ventricle has two flaps called cusps that meet when the valve is closed. The **tricuspid valve** between the right atrium and right ventricle is named for its three cusps. Figure 6-2 ► shows these valves in the closed position.

The pulmonary semilunar valve permits one-way blood flow from the right ventricle to the pulmonary artery, while the aortic semilunar valve controls blood flow from the left ventricle to the aorta.

During each pumping cycle of the heart, the chambers relax as they fill and then contract as they pump blood. The filling period is the **diastole**, or the diastolic phase, while the contracting phase of each chamber is the **systole**, or systolic phase. The alternating contraction and relaxation of atria and ventricles comprises the **cardiac cycle**, which takes about 0.8 of a second. The flow of blood through the heart chambers, vessels, and lungs is reviewed in Figure 6-3 ►.

Coronary arteries provide the heart muscle with a reliable blood supply. The left coronary artery begins at the aorta on the front of the heart and divides within an inch into the anterior interventricular coronary artery and the

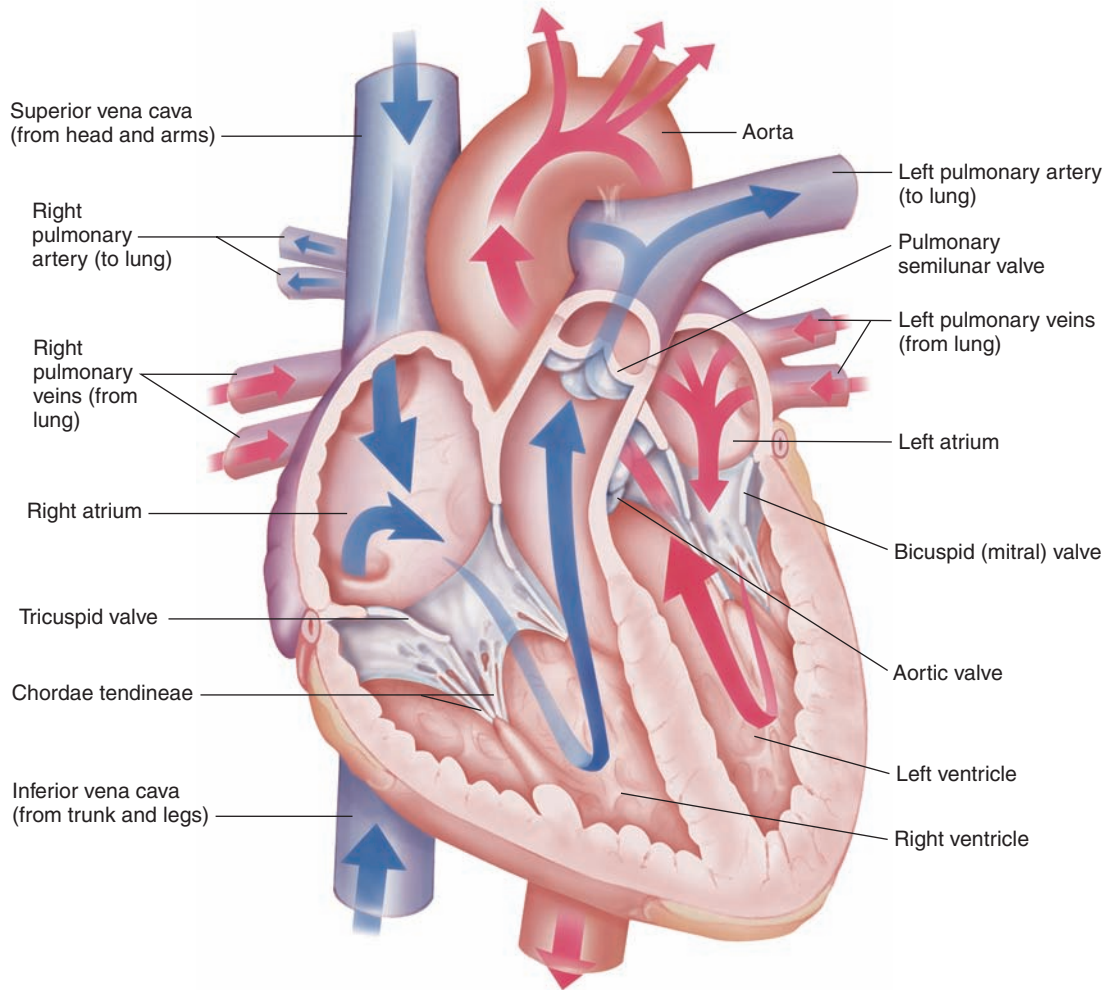


Figure 6-3 ► Blood flow through the heart.

circumflex artery, which continues left around the back of the heart. The right coronary artery also branches from the front of the aorta and sends divisions to the right side and back of the heart (Figure 6-4 ►).

Unlike skeletal muscle, cardiac muscle contracts continuously and rhythmically without conscious effort. A small patch of tissue, the **sinoatrial node** (SA node), acts as the pacemaker of the heart. The impulse for contraction initiates at the SA node, spreads over the atria, and passes to the ventricles via conductive tissue called the atrioventricular node (AV node). The impulse continues along left and right bundle branches and terminates in the **Purkinje fibers**, which further

branch throughout the ventricle walls. This conduction system is illustrated in Figure 6-5 ►.

Heart muscle contraction is influenced by the autonomic nervous system and hormones such as epinephrine. Two sets of nerves work antagonistically, one slowing the heart and the other accelerating it. The vagus nerve slows the heart rate during rest and sleep by means of a chemical it secretes, called acetylcholine. The excitatory portion of the autonomic nervous system increases the heart rate during periods of stress, strenuous physical activity, and excitement. This excitation is brought about by the release of epinephrine and norepinephrine, which stimulate the heart's pacemaker.

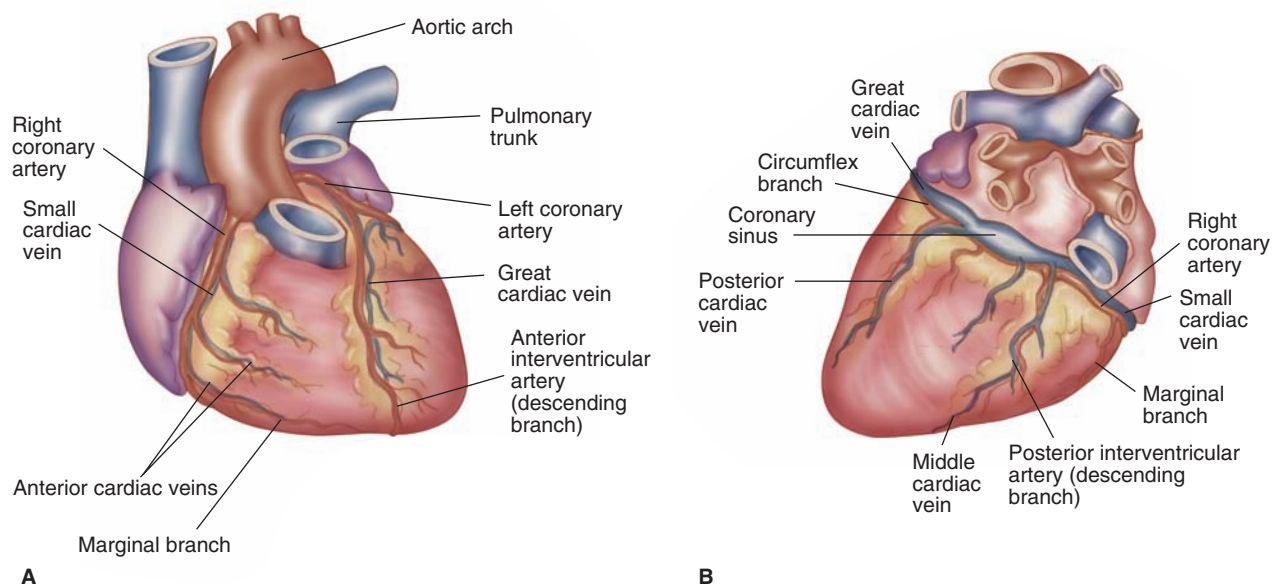


Figure 6-4 ► Coronary arteries and major vessels (A) anterior (B) posterior.

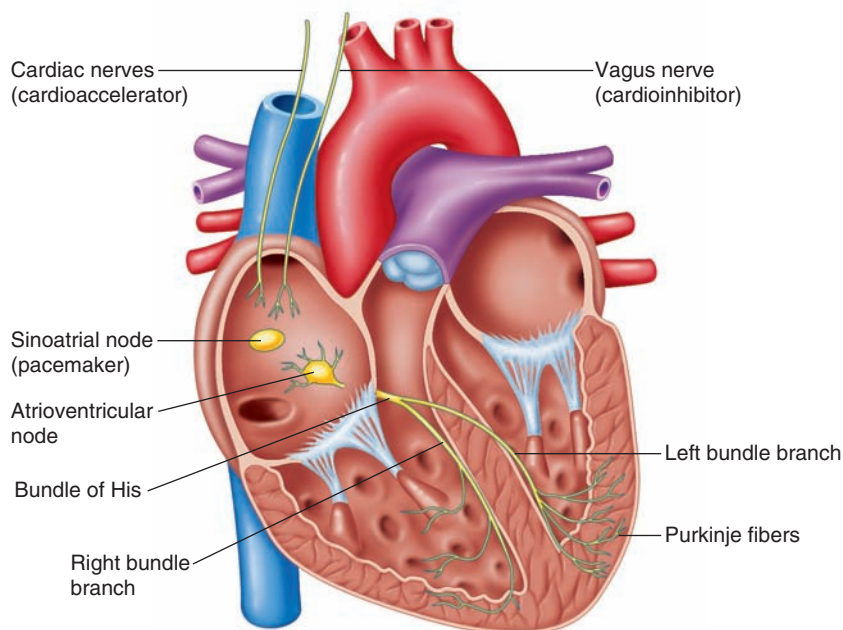


Figure 6-5 ► Conducting system of the heart.

Blood flows through two circulatory routes: the systemic circulation and the pulmonary circulation. The systemic circulation distributes oxygenated blood from the left ventricle, beginning at the **aorta** and continuing through the arteries to all parts of the body, and returns deoxygenated blood by veins to the right atrium. The pulmonary circulation carries deoxygenated blood from the right ventricle, beginning at the pulmonary trunk and continuing through smaller arteries to the lungs to be oxygenated, and returns the blood through pulmonary veins to the left atrium. Partitions called the interatrial septum and interventricular septum

separate oxygenated from deoxygenated blood in the atria and ventricles, respectively. See Figure 6-6 ► and Figure 6-7 ►.

Branches of the aorta carry blood to the head, upper extremities, chest, abdomen, pelvis, and lower extremities. These arteries continue to divide into smaller and smaller arteries, and eventually into vessels called **arterioles**, the smallest arteries. Arterioles lead into **capillaries**, the connecting links between arteries and veins. Blood in the capillaries, through the very thin capillary walls, delivers oxygen and nutrients to tissues and receives carbon dioxide and other wastes from the tissues. The now-deoxygenated

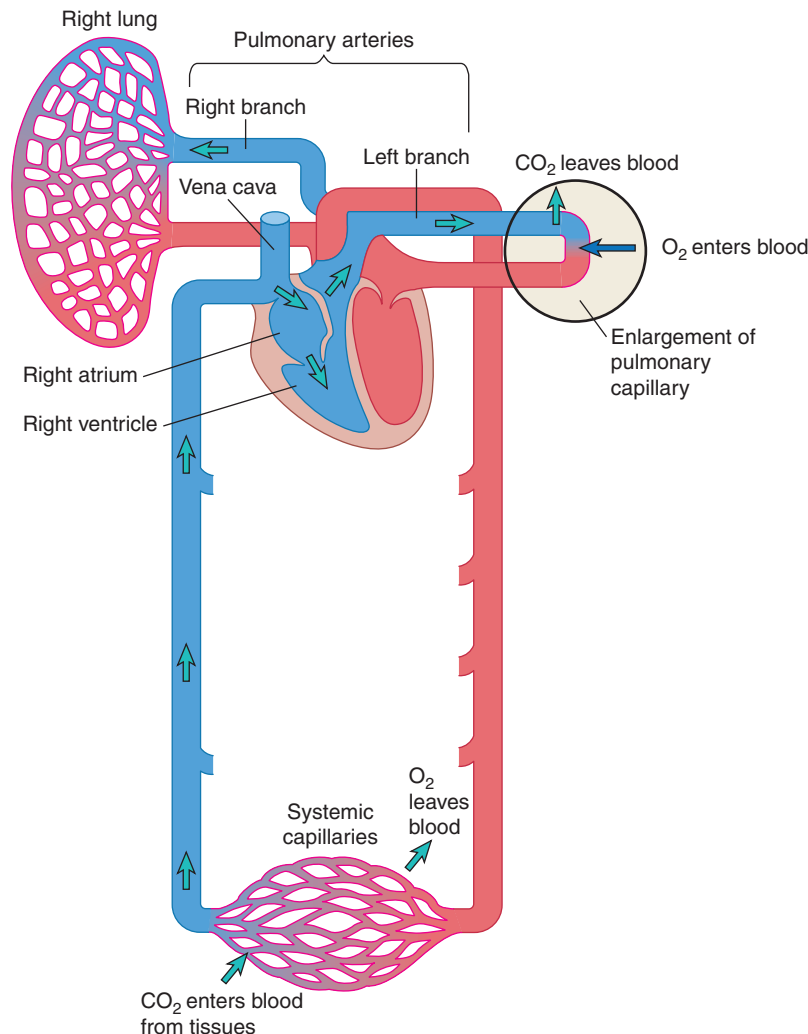


Figure 6-6 ► Venous return to the heart and blood flow to the lungs.

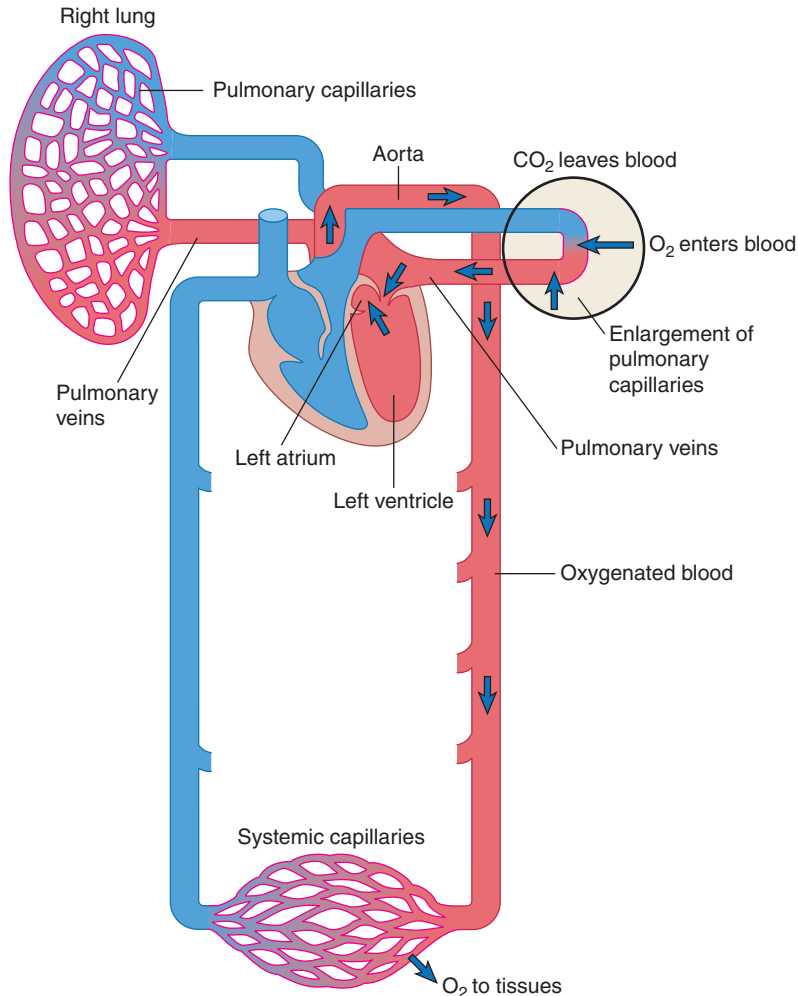


Figure 6-7 ► Return of oxygenated blood to the heart and entry into the aorta (red = oxygenated blood, blue = deoxygenated blood).

blood continues into **venules**, the smallest veins, and then into larger veins. Veins from the upper body empty blood into the superior vena cava, and veins of the lower body carry blood to the inferior vena cava. The superior and inferior **venae cavae** deliver systemic blood to the right atrium.

Structure and Function of the Blood Vessels

The walls of arteries are muscular, thick, strong, elastic, and are lined with endothelium. Arterioles have a smaller diameter than arteries, with

thinner walls consisting mostly of smooth muscle fibers arranged circularly and a lining consisting of endothelium. Arterioles can change their diameter by constricting or dilating, which alters blood flow to the tissues. Capillaries are minute vessels with a lumen as wide as a red blood cell. Their wall consists only of a layer of endothelium. Vein walls are much thinner than companion arteries, but their lumens are considerably larger. With less muscle and elasticity in their walls, veins tend to collapse when empty. Veins, particularly those of the legs, contain valves that help return blood upward to the heart against gravity.

Diagnostic Tests and Procedures

Many techniques are available for diagnosing cardiovascular diseases and disorders. **Auscultation**, listening through a stethoscope for abnormal sounds, and the electrocardiogram (ECG) provide valuable information regarding heart condition. The **electrocardiogram** is an electrical recording of heart action and aids in the diagnosis of coronary artery disease, myocardial infarction, valve disorders, and some congenital heart diseases. It is also useful in diagnosing arrhythmias and heart block (Box 6-1 ►). **Echocardiography** (ultrasound cardiography) is another noninvasive procedure that utilizes high-frequency sound waves to examine the size, shape, and motion of heart structures. It gives a time-motion study of the heart, which permits direct recordings of heart valve movement, measurements of the heart chambers during the cardiac cycle. Color **Doppler echocardiography** explores blood-flow patterns and changes in velocity of blood flow within the heart and great vessels. It enables the cardiologist to evaluate valve stenosis or insufficiency.

An exercise tolerance test is used to diagnose coronary artery disease and other heart disorders. This test monitors the ECG and blood pressure during exercise. Problems that normally do not occur at rest are revealed.

Cardiac catheterization is a procedure in which a catheter is passed into the heart through blood vessels to sample the blood in each chamber for oxygen content and pressure. The results can diagnose valve disorders or abnormal shunting of blood and aid in determining cardiac output (Figure 6-8 ►).

X-rays of the heart and great vessels, the aorta, and the pulmonary artery, in conjunction with **angiocardiography**, in which a contrast indicator (dye) is injected into the cardiovascular system,

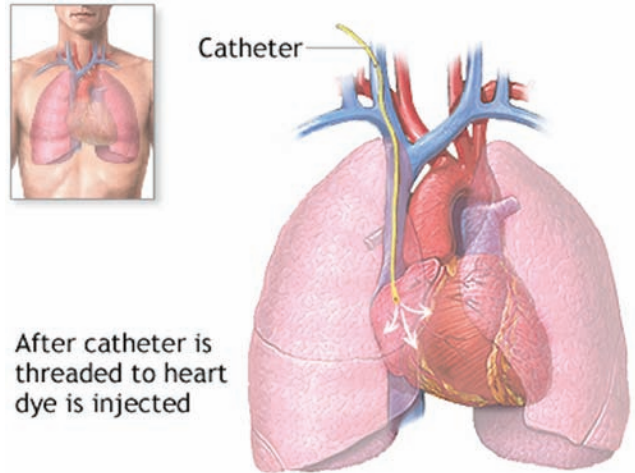


Figure 6-8 ► Cardiac catheterization.

can detect blockage in vessels. **Coronary arteriography** employs an injected contrast material that permits imaging of blood vessel function.

Cardiovascular Disease

Cardiovascular diseases affect the heart and the blood vessels. Cardiovascular diseases are the leading cause of death in the United States and worldwide. Approximately 700,000 people die of heart disease in the United States each year (Box 6-2 ►).

The Role of Lipids and Cholesterol in Cardiovascular Disease

Several diseases and disorders of the heart and blood vessels are associated with blood lipid and cholesterol levels. In some cases, these levels are modifiable through behavior, diet, exercise, and medication.

Hyperlipidemia Hyperlipidemia describes elevated lipids (fats) in the blood. Lipids include cholesterol, phospholipids, and triglycerides. Cholesterol is a soft, waxy substance that is normally found in cell membranes. The body also uses cholesterol to synthesize various hormones. It is transported throughout the systemic circulation by transport proteins called **lipoproteins**.

Low-density lipoprotein (LDL) is the major cholesterol carrier in the blood. LDL transports

BOX 6-1 What Can ECG Patterns Reveal?

- Heart attack
- Lack of blood flow to the heart
- Arrhythmia
- Heart failure
- Cardiomyopathy
- Congenital heart disease
- Heart valve disease

cholesterol to the tissues of the body. LDL is also known as the “bad” cholesterol because accumulation of LDL forms a **plaque**, or thick, hard deposit, that narrows arteries and impedes blood flow. As the level of blood LDL increases, the risk for heart disease increases. This is true in men and women, in different racial and ethnic groups, and at all ages.

High-density lipoprotein (HDL) carries about one-quarter to one-third of the cholesterol. Known as the “good” cholesterol, HDL carries cholesterol away from the arteries and to the liver, where it is eliminated from the body. Generally the higher the level of HDL, the lower the risk of coronary heart disease. Fat in the human body takes the form of **triglycerides**. High blood levels of triglycerides are linked to coronary artery disease. An estimated 35% of adults older than 20 years of age in the United States have high levels of LDL. Even so, only about half of these people receive treatment for elevated LDL. Therefore, elevated LDL places many adults at risk for heart disease.

Hypercholesterolemia Hypercholesterolemia describes abnormally high levels of blood cholesterol. Many types of hypercholesterolemia have a genetic basis. One of these is known as familial hypercholesterolemia. Secondary causes of hypercholesterolemia include obesity and diabetes mellitus. High-calorie diets increase the production of LDL and cholesterol. Diets that are high in triglycerides and saturated fat increase cholesterol synthesis and inhibit removal of cholesterol from the blood.

BOX 6-2 Risk Factors for Cardiovascular Disease

Modifiable Risk Factors

Hypertension
Cigarette smoking
Diabetes
Obesity
Physical inactivity
High-fat and -cholesterol diet

Nonmodifiable Risk Factors

Age
Male sex
Family history of premature death due to coronary heart disease

Diseases of the Arteries

Diseases of the arteries impair blood flow and oxygenation of tissues. Arterial diseases can also elevate blood pressure. Some of the leading risk factors for arterial disease include cigarette smoking, high blood lipid and cholesterol levels, and hypertension.

Arteriosclerosis In **arteriosclerosis**, artery walls thicken and become hard and inflexible, partly due to calcium deposition. “Hardening of the arteries,” the common name for this condition, aptly describes it, because affected arteries are unable to stretch and rebound in response to the pressure of blood as it is forced through them by contraction of the heart. As a result, arteriosclerosis leads to hypertension. The most common cause of arteriosclerosis is atherosclerosis (discussed next) in which fatty material accumulates within the walls of the artery. Smoking also leads to arteriosclerosis (Figure 6-9 ►).

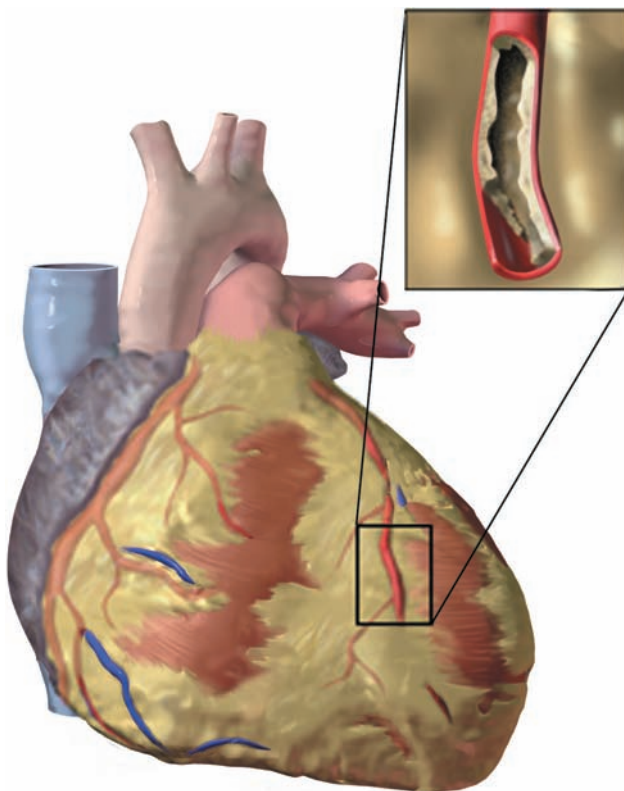


Figure 6-9 ► An atherosclerotic artery.

Atherosclerosis **Atherosclerosis** is a thickening, narrowing, and hardening of arteries. High lipid blood levels, hypercholesterolemia, smoking, hypertension, and diabetes are known risk factors for atherosclerosis. The prevalence of atherosclerosis is not known, but it is estimated to occur in the majority of adults in the United States. Atherosclerosis begins in young adults and can progress throughout adulthood.

The simplest form of atherosclerosis is **fatty streaks**, which are thin, flat discolorations in the arteries that can enlarge and become thicker as they grow in length. Fatty streaks are present in children and increase in number until about age 20, and then they either remain static or regress.

Over time, arteries may develop a **fibrous atheromatous plaque**, which is the medically important feature of atherosclerosis. It is characterized by the accumulation of lipids and the formation of scar tissue. The fibrous atheromatous plaque begins as a whitish-gray thickening of the inner lining of an artery. This region contains a lipid core covered by plaque. As the plaque increases in size, the artery may eventually become narrowed and blocked, causing reduced blood flow (Figure 6–10 ►). The plaque may hemorrhage, ulcerate, and scar. **Thrombosis**, a clot within a blood vessel, forms because of ulceration and turbulent blood flow in the region of the plaque.

Males and people with a history of cardiovascular disease have an increased risk for atherosclerosis. Modifiable risk factors such as hypercholesterolemia, high blood pressure, diabetes, obesity, physical inactivity, untreated or undertreated hypertension, and smoking can be controlled to reduce the risk for atherosclerosis.

Atherosclerosis is not usually associated with symptoms until the interior of the artery is extensively narrowed (occluded). Symptoms depend on the location and the severity of the occlusion. Occlusion of the coronary arteries may result in chest pain and shortness of breath. Blockage of the **carotid arteries** can reduce blood supply to the brain, causing a stroke. A hardening of the arteries in the legs, or **peripheral vascular disease**, leads to pain in the muscles of the leg; in severe cases ulcers and infections develop in the extremities.

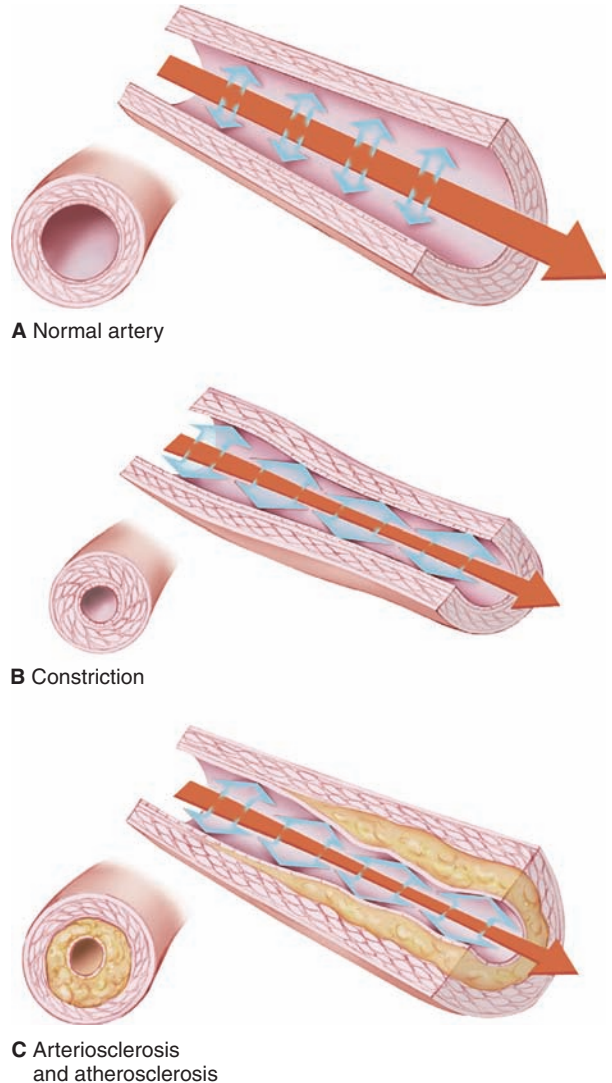


Figure 6–10 ► Blood vessels: (A) normal artery; (B) constriction; (C) arteriosclerosis and atherosclerosis.

Atherosclerosis of coronary arteries can be diagnosed by electrocardiogram, coronary angiography, and CT. Atherosclerosis can be slowed or stopped by controlling blood pressure, reducing blood cholesterol and lipids, and by exercise. Treatment includes antihypertensive and cholesterol-lowering medications. Treatment of atherosclerosis in coronary arteries and peripheral arteries will be discussed with heart disease.

Peripheral Arterial Disease Diseases that affect peripheral arteries also produce **ischemia**, a loss of blood and oxygen supply. Reduced blood

flow causes pain, impaired function, and tissue necrosis. Atherosclerosis is an important cause of peripheral arterial disease. The most commonly affected arteries are the femoral (upper leg) or popliteal (lower leg) arteries. The disease occurs most commonly in men 70–80 years of age. The risk factors for this disease are the same as those for atherosclerosis and include heredity, high-fat diet, smoking, and physical inactivity.

The primary symptom of peripheral artery disease is **intermittent claudication**, or pain with walking. Other signs include a thinning of the skin and subcutaneous tissues of the lower leg. The foot may feel cool to the touch and a lower leg pulse may be faint or absent. When blood flow is significantly reduced, the leg starves for oxygen. In such cases pain occurs even at rest, and ulcers and infections develop.

Diagnosis depends on the physical exam. The affected limb will show signs of ischemia, such as pallor, coolness, and weak pulse. Ultrasound and angiography may confirm the diagnosis and pinpoint the affected part of the arteries.

Treatment of peripheral vascular disease is aimed at prevention of further complications. Walking slowly increases circulation around the clots. It is important to avoid injury because extremities affected by atherosclerosis heal slowly. Blood-thinning agents are used to prevent additional clots from forming. Severe cases are treated with surgical bypass around the clot.

Raynaud's Disease Raynaud's disease is a disorder of the arteries in the fingers and toes. The arteries suddenly contract, a phenomenon called vasospasm. The prevalence of Raynaud's in the United States is 11% in women and 8% in men. The risk factors are sex, age, and stress and the risk for Raynaud's is highest among young women. Although the cause is unknown, vasospasms are triggered by exposure to cold or emotional stress (Figure 6–11 ►).

Symptoms of vasospasm include pallor or cyanosis and cold, numb, or tingling fingers. The color changes are most noticeable in the tips of the fingers. In severe progressive disease, the nails may become brittle, and the skin over the affected fingers may thicken. Deprivation of oxygen and nutrients in the affected area may give rise to arthritis, ulcers, and sometimes infection in the fingers.

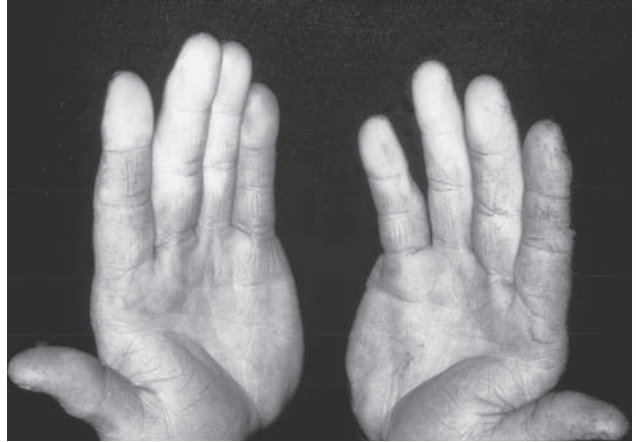


Figure 6–11 ► Raynaud's disease. (Courtesy of Centers for Disease Control and Prevention)

Diagnosis requires a physical exam and patient history of signs and symptoms. Treatment of Raynaud's disease is aimed at reducing triggers for the symptoms and protecting the hands from trauma. People should stop smoking, protect the hands from cold, and avoid emotional stress. Medications can help prevent vasospasm.

Aortic Aneurysm Aortic aneurysm is an abnormal dilation of the aorta. The prevalence is not precisely known, but risk factors include sex, age, smoking, hypertension, and atherosclerosis. Aortic aneurysms are most prevalent in men over age 50. Aneurysm results from weakness in the aorta wall, which can be caused by an inherited disorder, hypertension, atherosclerosis, or inflammation and infection of the artery.

Signs and symptoms may be absent for some time as the aneurysm progresses. Sometimes a burst aneurysm is the first sign of a problem. Aneurysms are usually described by their location, size, shape, and origin. The shape of an aortic aneurysm is described as either **fusiform** or **saccular** (Figure 6–12 ►). A **fusiform** aneurysm has a uniform shape, tapered at both ends, with symmetrical dilation. **Saccular** aneurysms, on the other hand, appear as an out-pouching of a portion of the aortic wall. Aneurysms usually occur in the abdomen below the kidneys (**abdominal aortic aneurysm**) or in the chest cavity (**thoracic aneurysm**). **Cerebral or brain aneurysm** is diagnosed less frequently. Regardless of location, the danger of an aneurysm is the tendency to increase in size and

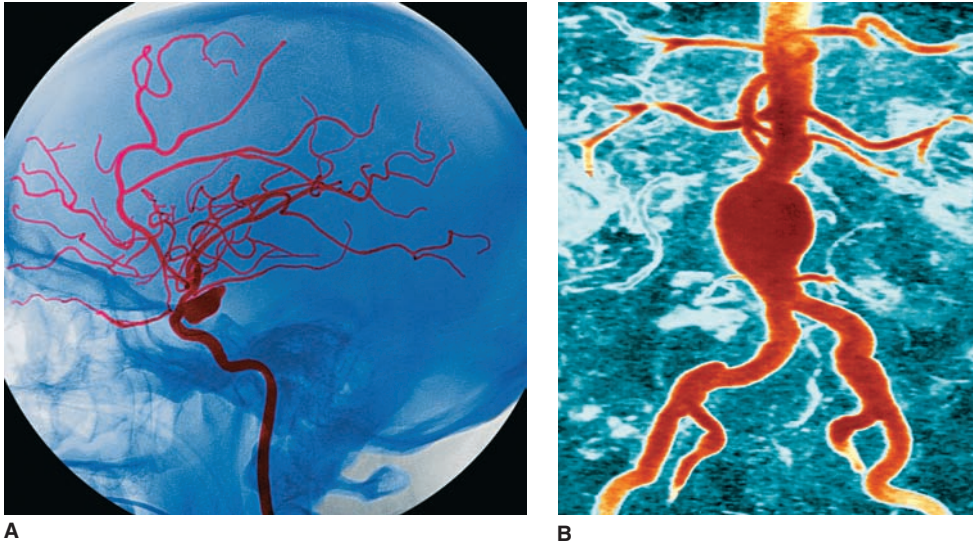


Figure 6-12 ► Aneurysms: (A) saccular (Simon Fraser/RNC, Newcastle/Photo Researchers, Inc.); (B) fusiform. (Zephyr/Photo Researchers, Inc.)

rupture, resulting in hemorrhage, possibly in a vital organ such as the heart, brain, or abdomen.

Ultrasound imaging, echocardiography, computed tomography (CT), and magnetic resonance imaging (MRI) scans are often used to diagnose and monitor the progression of an aneurysm. Treatment for some aneurysms includes surgical repair. The diseased area of the vessel is removed and replaced with an artificial graft or segment of another blood vessel.

Hypertension Arterial blood pressure is a measure of the force of blood against the arterial walls. Hypertension is sustained and excessively high blood pressure. In healthy adults, the highest pressure, called the **systolic** pressure, is ideally less than 120 mm Hg, and the lowest pressure, called the **diastolic** pressure, is less than 80 mm Hg. Blood pressure normally varies throughout the day, increasing with activity and decreasing with rest (Table 6-1 ►). Hypertension is broadly defined as an arterial pressure greater than 140/90 mm Hg in adults on at least three consecutive measures. A systolic pressure of 120–139 mm Hg or a diastolic pressure of 80–89 mm Hg is classified as **prehypertension**.

Hypertension is the most common cardiovascular disorder and affects about 20% of the adult population worldwide. It is considered one of the major risk factors for heart disease,

stroke, and kidney disease (Table 6-2 ►). Due to the asymptomatic nature of hypertension, it remains untreated or undertreated in the majority of affected individuals.

TABLE 6-1 Adult Blood Pressure Guidelines

Healthy (normal)	Below 120/80 mm Hg
Prehypertension	120/80 to 139/89 mm Hg
Stage 1 hypertension	140/90 to 159/99 mm Hg
Stage 2 hypertension	160/100 mm Hg

TABLE 6-2 Risk of Stroke and Heart Disease Increase with Increasing Blood Pressure

Blood pressure (mm Hg)	Risk
115/75	Normal
135/85	2 times normal
155/95	4 times normal
175/105	8 times normal

Prevention PLUS!

Risk Factors for Coronary Heart Disease

Several risk factors have been identified for coronary heart disease. These risk factors can be divided into modifiable risk factors and those that cannot be modified. Modifiable risk factors include cigarette smoking, a high-fat diet, overweight and obesity, and physical inactivity. Screening and early interventions for nonmodifiable risk factors such as family history and genetics provide an opportunity for early interventions to improve health outcomes.

Think Critically

1. List your modifiable and non-modifiable risk factors. Which modifiable factors are easiest for you to change? Which are the most difficult to change? Explain your answer.
2. How do genetics, behavior, and environment interact to influence the risk for heart disease?

Risk factors for hypertension include advancing age, sedentary lifestyle, excess weight, and excessive dietary salt and alcohol consumption. Family history of hypertension and African American ancestry are also risk factors for hypertension. Prehypertension also raises the risk for developing hypertension.

The etiology of hypertension is classified as primary or secondary. Primary hypertension, also called **essential hypertension**, is a sustained increase in systolic and diastolic blood pressure without evidence of other disease. Approximately 90–95% of hypertension is classified as primary or essential. In **secondary hypertension**, the elevation in blood pressure results from some other disease, such as kidney disease.

Symptoms of hypertension are absent in most cases. Extreme and persistent hypertension causes headache, dizziness, and agitation. However, hypertension often causes no symptoms and can remain unrecognized for years. Later

signs and symptoms are related to the effects of hypertension on kidneys and eyes, and the development of cardiovascular disease.

Diagnosis of hypertension requires blood pressure measurements with a sphygmomanometer and stethoscope. The diagnosis of hypertension using this method is based on the average of at least two or more blood pressure readings taken on at least two separate physician office visits.

Treatment of primary and secondary hypertension is aimed at reducing blood pressure to less than 140/90 mm Hg and preventing organ damage. For individuals with secondary hypertension, it is important to take control of the disease causing the hypertension. Lifestyle modifications such as weight loss, exercise, and reduction of salt intake enhance the effectiveness of medication therapy and help reduce further disease risks. The type of medication selected to treat hypertension depends on the stage of hypertension, age, other conditions, and patient-specific risk factors.

Prevention PLUS!

Sodium Intake

Most Americans consume more salt (sodium) than their bodies need. Heavy sodium consumption increases blood pressure in some people; a 25–35% reduction in salt intake can reduce the likelihood of heart attack or stroke. You can take action to reduce your blood pressure and decrease the likelihood of stroke or heart attack in the following ways:

- Lose weight Weight loss is the single most effective nondrug method to reduce blood pressure.
- Exercise Thirty to 35 minutes of exercise three times per week can decrease blood pressure, especially when combined with weight loss.
- Limit alcohol consumption Alcohol raises blood pressure, even in the absence of hypertensive disease.
- Reduce fat intake and increase vegetable and fruit intake A diet high in vitamins and low in fats is associated with lower blood pressure.
- Reduce dietary salt intake Keep salt intake below 2400 mg per day, or less than 1 teaspoon (tsp) daily.

Diseases of the Venous Circulation

The venous systems in the lower extremities consist of the superficial (saphenous) veins and a number of deeper veins. Blood from the skin and the subcutaneous tissue accumulates in the superficial veins and then is transported into the deeper veins for return to the heart. Valves are located along the veins and prevent backflow of blood into the venous system. The leg muscles also assist in moving venous blood from the lower extremities to the heart.

Varicose Veins Varicose veins are dilated, distorted veins that usually develop in the superficial veins of the leg, such as the greater saphenous vein. The veins become swollen and painful and appear knotty under the skin. Varicose veins are caused by blood pooling within the veins because of decreased, stagnated blood flow (Figure 6–13 ►). The prevalence is unknown; recognized risk factors for varicose veins include pregnancy, sedentary lifestyle, obesity, and family history.

Varicose veins can be caused by pregnancy or occupations requiring long periods of sitting or standing. Normally, the leg muscle action squeezes blood up within the vein from one valve to the next. In the absence of this “milking action”

of the muscles, the blood exerts pressure on the closed valves and thin walls of the veins. The veins dilate to the extent that the valves no longer work. The blood collects and becomes stagnant.

Signs and symptoms include swollen, twisted, and sometimes painful veins in the lower legs. **Spider veins** are small, dense networks of veins that appear as red or blue discolorations on the skin. Complications of varicose veins include ulcers, infection, and hemorrhage. Treatment depends on the severity of the symptoms. An elastic bandage or support hose may increase circulation and provide relief from discomfort. Symptoms can be relieved by walking, elevating the legs when seated, and losing weight. A surgical procedure called surgical vein stripping is very successful and involves removing the veins and tying off the remaining open ends. Collateral circulation tends to develop to compensate for the loss of the vein segment. Another treatment is **compression sclerotherapy**, in which a strong saline solution is injected into specific sites of the varicose veins. The irritation causes scarring of the inner lining and fuses the veins shut. The procedure is followed by uninterrupted compression for several weeks to prevent reentry of blood. A daily walking program during the recovery period is required to activate leg muscle venous pumps.

It is difficult to prevent varicose veins. However, the risk can be reduced by alternating long periods of sitting or standing with leg movement and exercise.

Chronic Venous Insufficiency Chronic venous insufficiency (CVI) is a condition of poor venous blood return to the heart. While the precise prevalence is not known, CVI occurs mostly in middle age women and in men age 70 and over. Risk factors for CVI include advancing age, family history of deep vein thrombosis, sedentary lifestyle, obesity, and smoking. The most common cause of CVI is deep vein thrombosis.

Signs and symptoms include tissue edema, necrosis or skin atrophy, and pain during walking. In advanced disease, venous stasis ulcers may develop. CVI can be diagnosed with physical exam and patient history. Diagnostic tests include ultrasound, venography, CT, MRI, and a blood test for a blood factor called D dimer.

The treatment of CVI depends on the severity of the disease. Mild cases can be managed with diet and exercise and the use of compression

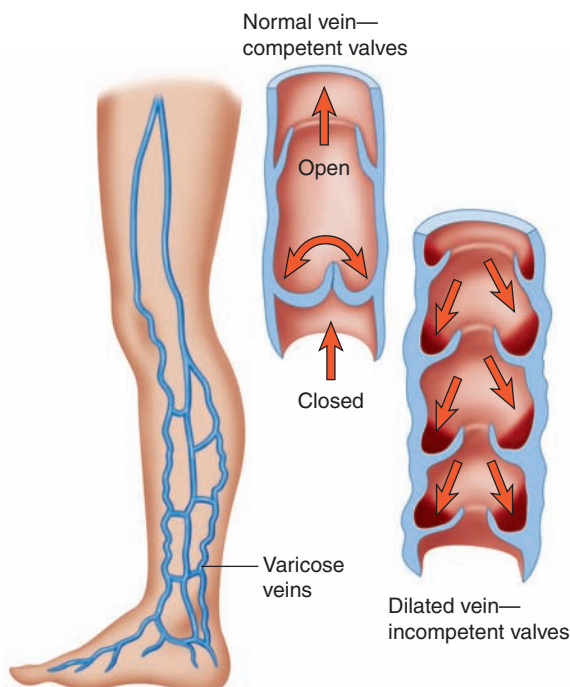


Figure 6–13 ► Development of varicose veins.

TABLE 6–3 Risk Factor Categories for Atherosclerotic Cardiovascular Disease

Major risk factors	Emerging risk factors	Underlying risk factors
<ul style="list-style-type: none"> • Cigarette smoking • Elevated blood pressure • Elevated LDL cholesterol • Low HDL cholesterol • Diabetes mellitus • Metabolic syndrome 	<ul style="list-style-type: none"> • Prothrombotic state • Proinflammatory state • Insulin resistance 	<ul style="list-style-type: none"> • High-fat diet • Obesity • Physical inactivity • Family history
<p>Source: Adapted from Grundy SM. “Cardiovascular and Metabolic Risk Factors: How Can We Improve Outcomes in the High-Risk Patient.” <i>American Journal of Medicine</i>, 2007;120(9A):S3–S9.</p>		

stockings. Compression stockings squeeze the leg and prevent excess blood from flowing backward. Surgery includes valve repair, bypass, and vein stripping. CVI can be prevented by reducing the known risk factors.

Venous Thrombosis A clot, or **venous thrombosis**, can develop in the superficial or the deep veins of the lower extremities. The prevalence is not well known because many cases are asymptomatic. However, risk factors are understood and include venous stasis, vascular trauma, and conditions that promote blood clotting. Older adults and postsurgical patients are at increased risk for venous thrombosis because immobility reduces blood flow in the extremities.

Signs and symptoms do not occur in about half of cases. When they do occur, signs and symptoms include inflammation, pain, swelling, and deep muscle tenderness. Early detection and prevention of venous thrombosis can prevent potentially fatal complications such as **emboli**, or clots that travel to vital organs such as the lungs. Diagnosis requires physical exam, history, ultrasound, venography, CT, MRI, and a blood test for D dimer. Treatment includes blood thinning medications and surgery to remove the clot. Prevention depends on reducing risk factors. Prevention includes walking soon after surgery or childbirth, exercising the legs, and use of compression stockings.

Heart Diseases and Disorders

Coronary Heart Disease Coronary heart disease (CHD) is a disease of reduced coronary blood flow. Coronary heart disease is the leading cause of death worldwide. Approximately 3.8 million

men and 3.4 million women worldwide die each year from coronary heart disease. The risk factors include hypertension, family history, sedentary lifestyle, overweight, high blood lipid levels, atherosclerosis, and smoking. See Table 6–3 ►. More than 90% of persons with CHD have coronary atherosclerosis.

Symptoms of CHD include chest pain, or **angina pectoris**, which is pain and pressure felt in the chest that results from ischemia; **palpitations**, or a sensation of a rapid pounding heartbeat; dizziness or fainting; weakness upon exertion or at rest; and shortness of breath. The most devastating sign of CHD is cardiac arrest or a heart attack, also known as a **myocardial infarction** (Figure 6–14 ►). Crushing pain in the chest, shortness of breath, nausea, pallor, weakness, and faintness are among the symptoms of a myocardial infarction.

Diagnosis of coronary heart disease requires a physical exam, patient medical history, and an electrocardiogram (ECG). A patient’s medical history is used to identify hereditary and lifestyle risk factors for the disease. The ECG records the heart’s electrical activity and can aid in identifying abnormalities in heart rate and rhythm as well as areas of damaged heart tissue. Additional diagnostic tests include echocardiograms, stress tests, nuclear imaging, and angiography.

Treatment of CHD depends on the severity of the disease. Medications include blood pressure-lowering agents, blood thinners, diuretics (medication that increases excretion of water), nitrates such as nitroglycerin to stop chest pain, and lipid-lowering medication. Lifestyle changes, such as a healthy, low-salt diet and exercise, are important to prevent further progression of the disease.

Angioplasty is a procedure used to open a partly occluded artery (Figure 6–15 ►). The procedure

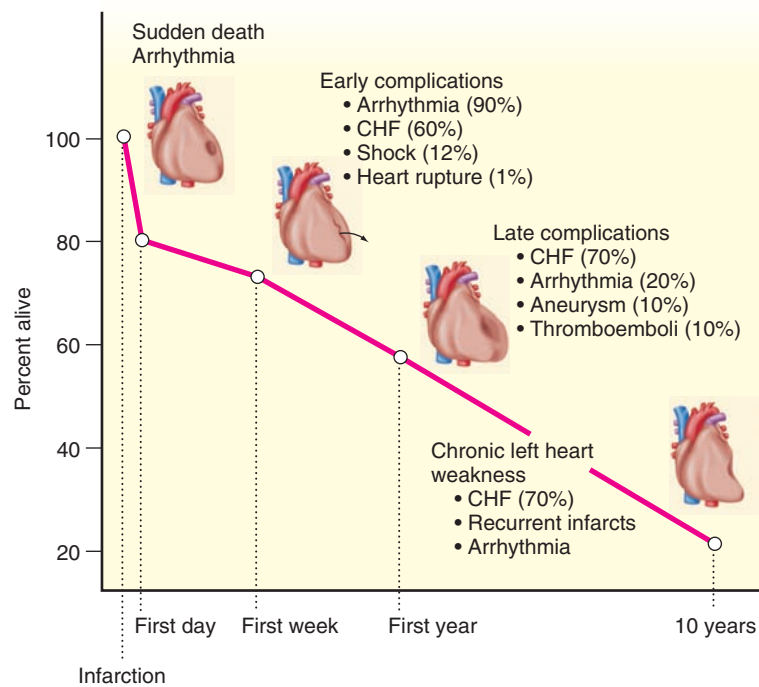


Figure 6-14 ► Outcome of myocardial infarction. Forty percent of 1-week survivors have late complications resulting in death. Ten-year survival rate is about 25%.

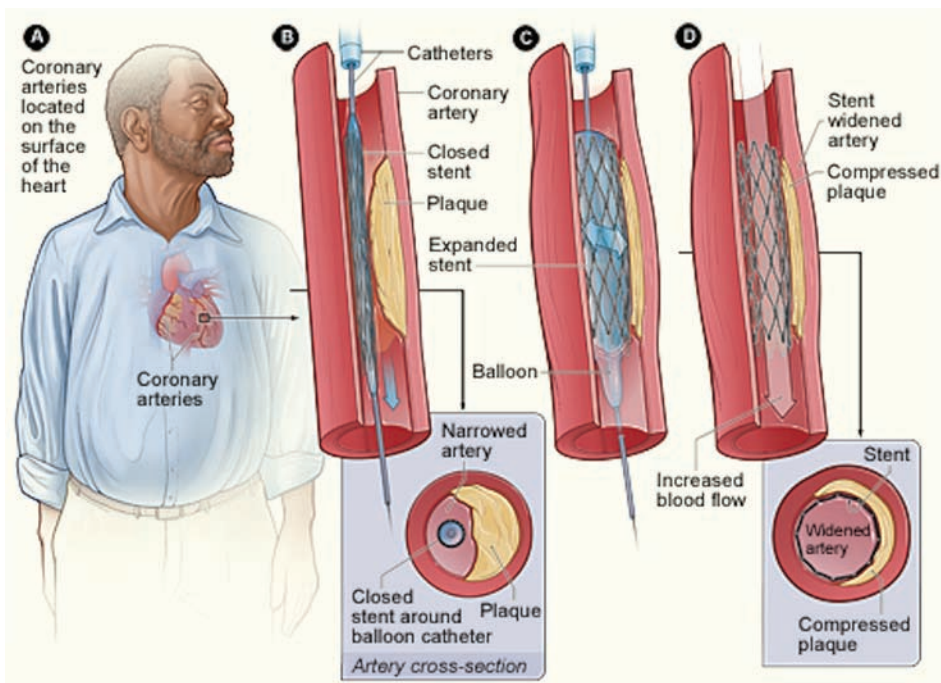


Figure 6-15 ► Angioplasty with stent placement. (National Institutes of Health)

involves inserting a balloon-tipped catheter into the femoral artery, then guiding it to the heart and into the narrowed coronary artery. The balloon is expanded to press against the vessel walls and open the lumen. A stent, which is a cylindrical wire mesh of stainless steel or other alloy, surrounds the balloon. Expansion of the balloon forces the mesh into the lining of the vessel, which physically holds the lumen open. Because the vessels commonly become occluded again (restenosis) within months or a year, stents are coated with drugs that prevent restenosis.

Severe blockage of the coronary arteries is treated with artery bypass surgery. Coronary artery bypass surgery reroutes blood flow around the clogged arteries to improve blood flow and oxygen supply to the heart. A segment of a healthy blood vessel from another part of the body is attached or grafted from the aorta to the coronary artery below the blocked area. Depending on the number of blocked arteries, one or more grafts may be surgically placed. See Figure 6-16 ►.

Myocardial Diseases

Myocarditis Myocarditis is an inflammatory disease of the heart muscle. Myocarditis is associated with several other types of diseases and infections, so the prevalence of myocarditis alone is not well known. Risk factors for myocarditis include viral infections such as Coxsackie virus, parvovirus, adenovirus, and echovirus. HIV/

AIDS, Lyme disease, streptococcal and staphylococcal infections, and illegal drug use are also risk factors for developing myocarditis.

Myocarditis is asymptomatic in early and mild cases. Signs and symptoms may include flu-like illness, fatigue, fever, chest pain that may feel like a heart attack, shortness of breath, and tachycardia, or a rapid heartbeat. Diagnosis depends on ECG, MRI, CT, chest x-ray, echocardiogram, and cardiac catheterization. Blood culture can determine the presence and nature of an infection. Blood tests for heart muscle enzymes evaluate the presence and extent of myocardial cell damage.

Treatment of underlying causes is important. However, in some cases myocarditis resolves on its own. Antibiotics or antiviral medications are used to treat underlying infections. If the heart has become weakened, medications may be given to reduce blood pressure and heart workload.

Cardiomyopathy Cardiomyopathy is a disorder in which the heart becomes weakened and enlarged or rigid. The precise prevalence is unknown, but cardiomyopathy is associated with age and prior heart disease. Risk factors also include hypertension, myocarditis, and viral or bacterial infections. Three types of cardiomyopathy occur (Figure 6-17 ►). **Dilated cardiomyopathy** is the most common form and is characterized by dilation of the ventricle, contractile dysfunction, and symptoms of congestive heart failure. Ventricular hypertrophy is the dominant feature

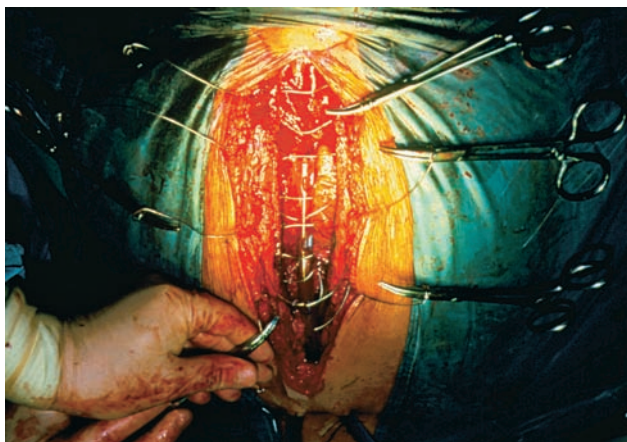


Figure 6-16 ► Bypass surgery of coronary blocked arteries. (Antonia Reeve/Photo Researchers, Inc.)

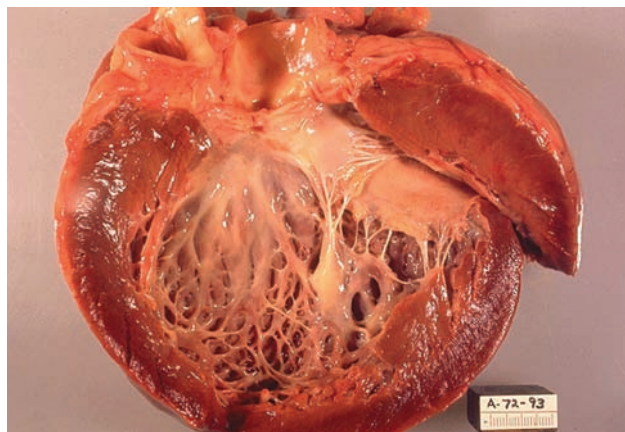


Figure 6-17 ► Cardiomyopathy. (Centers for Disease Control and Prevention/Dr. Edwin P. Ewing, Jr.)

of **hypertrophic cardiomyopathy**. Hypertrophic cardiomyopathy is the most common cause of sudden cardiac death among young people. **Restrictive cardiomyopathy** is the least common form and is associated with reduced filling of the heart and endocardial scarring in the ventricle.

The symptoms of cardiomyopathy include shortness of breath, weakness, fatigue, ascites, and peripheral edema. Treatment depends on the type of cardiomyopathy and the underlying causes. Treatment relieves symptoms with medications and rest. In rare and serious cases, those who qualify may undergo heart transplantation. Cardiomyopathy is not truly preventable except by reducing the risk factors and by treating the underlying diseases.

Endocardial Diseases

Endocarditis Endocarditis is an infection of the endocardium and the heart valves. Endocarditis is most prevalent in people with heart valve disorders or other heart disorders. Endocarditis does not affect a healthy heart. Risk factors include rheumatic heart disease, heart valve disease, degenerative heart disease, congenital heart disease, and intravenous drug abuse.

Many species of bacteria and fungi cause endocarditis. Acute forms of endocarditis involve the formation of nodules or **vegetations** that consist of the infectious organisms and cellular debris enmeshed in a fibrous clot. Typical lesions of endocarditis are shown in Figure 6–18 ►. As fragments of the vegetations break apart, they enter the bloodstream to form emboli, which can travel to the brain, kidney, lung, or other vital organs. The emboli can lodge in small blood vessels of the skin or other organs and cause the blood vessels to rupture.

Symptoms of infective endocarditis include fever, chills, a change in the sound or character of an existing heart murmur, and evidence for embolization of the vegetative lesions. A blood culture test provides a definitive diagnosis of the causative organism. Echocardiograms, CT, and ECG can detect underlying valve disease. Treatment requires antibiotics. Heart valve damage can be repaired with surgery. Endocarditis can be prevented only by treating heart disease and valve diseases and avoiding illegal IV drug use.

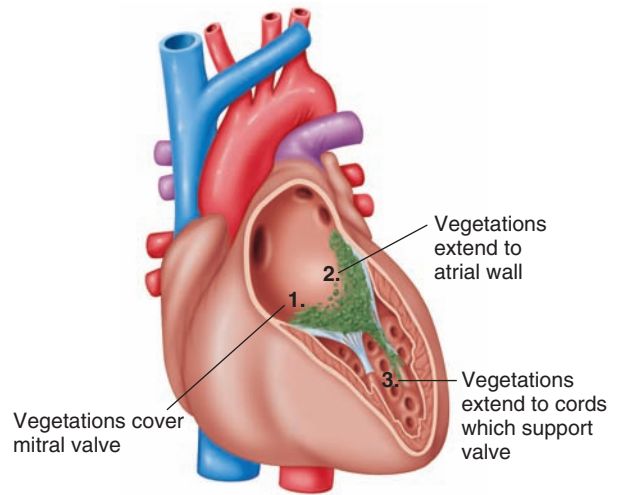


Figure 6–18 ► Bacterial endocarditis.

Rheumatic Fever Rheumatic fever is an autoimmune disease of heart tissue and heart valves. Rheumatic fever is very rare in the United States. The incidence of rheumatic fever is highest among children 5–15 years of age. The risk factors include age and infection with group A hemolytic streptococci.

Signs and symptoms begin approximately 2 weeks following a streptococcal infection. Rheumatic fever signs and symptoms include fever, inflamed and painful joints, and sometimes a rash. All parts of the heart may be affected, frequently including the mitral valve. Some individuals develop uncontrolled jerky movements in the hands. Blood clots deposit on the cusps of inflamed valves, forming nodular structures called vegetations. The normally flexible cusps thicken and adhere to each other. Later, fibrous tissue develops, which has a tendency to contract. If the adhesions of the cusps seriously narrow the valve opening, the mitral valve becomes stenotic. If sufficiently damaged, the cusps may not be able to meet properly, resulting in stenosis of the heart valves. Left untreated, rheumatic fever can cause permanent heart damage.

Diagnosis depends on physical exam, history of a streptococcal infection, ECG, and echocardiogram. Treatment includes antibiotics and anti-inflammatories. Medications may be used to control the involuntary muscle contractions. The best way to prevent rheumatic fever is to promptly treat streptococcal infection with antibiotics.

Diseases of the Heart Valves Valves maintain unidirectional flow of blood through the heart. Valve disorders include stenosis and valvular insufficiency. **Stenosis** refers to a narrowing of the valve opening and failure of the valve to open normally. Stenotic valves produce distention of the heart chamber that empties blood through the diseased valve and impaired filling of the chamber that receives the blood. **Valvular insufficiency** or **regurgitation** refers to a valve that allows backward flow of blood within the heart.

The prevalence of valve disorders is unknown because many cases do not get diagnosed or cause no symptoms. Valve disorders affect people of all ages. Risk factors include increasing age, family history of valve disorders, and history of rheumatic fever. Valve disorders can affect all valves. The most common problems are mitral valve stenosis, mitral valve insufficiency (prolapse), aortic valve stenosis, and aortic valve insufficiency (prolapse). Signs and symptoms may be absent except for the presence of characteristic heart sounds. Advanced disease causes hypertrophy and weakening of the heart muscle, shortness of breath, and cyanosis. Complications include congestive heart failure. Diagnosis depends on listening to heart murmurs with a stethoscope, and imaging with echocardiogram, transesophageal echocardiogram, ECG, and cardiac catheterization. Treatment may be unnecessary. However, serious valve damage may require surgical valve replacement or repair. Valve disorders cannot be prevented. The risk can be reduced by prompt treatment of rheumatic fever and streptococcal infections.

Cardiac Conduction Disorders Electrical impulses from the heart's pacemakers stimulate contraction of the atria and the ventricles. Many forms of heart disease can disrupt the normal contraction and relaxation cycle of the atria and ventricles.

Cardiac Arrhythmias Abnormal heart rhythms, or **arrhythmias**, develop from irregularity in impulse generation and impulse conduction. Two types of cardiac arrhythmias are supraventricular and ventricular. The **supraventricular arrhythmias** include those that are generated by electrical abnormalities in the sinoatrial (SA) node, atria, atrioventricular (AV) node, and junctional tissue

in the heart. The **ventricular arrhythmias** include those that are generated in the ventricular conduction system and in the ventricle. Because the ventricles pump blood from the heart, ventricular arrhythmias are serious and potentially life-threatening. Risk factors include family history, atherosclerosis, coronary artery disease, smoking, and alcohol and drug abuse. The etiologies of arrhythmias are numerous and include a history of coronary heart disease, heart valve disease, myocardial infarction, hypertension, atherosclerosis, metabolic diseases, smoking, and drug abuse. Several rhythm disorders occur.

- Tachycardia, sustained heart rate greater than 100 beats per minute
- Bradycardia, abnormally low heart rate less than 50 beats per minute
- Atrial fibrillation, disorganized, uncoordinated contraction of atria
- Ventricular fibrillation, disorganized, uncoordinated contraction of ventricles
- Heart block, atria and ventricles contract independent of each other

Atrial fibrillation is the most common heart rhythm disorder. Ventricular fibrillation is a life-threatening emergency, a form of cardiac arrest. Signs and symptoms of cardiac rhythm disorders include **syncope** or lightheadedness, edema, or shortness of breath.

Treatment includes medications, electrocardioversion (Figure 6–19 ►), and catheter ablation. Anti-arrhythmic medications alter the



Figure 6–19 ► Electrocardioversion paddles.

physiological properties of the heart's conduction system. Electrocadioversion is accomplished using an external device or a surgically placed internal pacemaker. A machine called an automated external defibrillator (AED) delivers electrical shocks and is used to reestablish normal heart rhythm. Defibrillators implanted under the skin of the shoulder resynchronize the heart on a daily basis, similar to a pacemaker device. Catheter ablation is a nonsurgical procedure in which a catheter is inserted into the diseased area of the heart. A machine directs energy through the catheter to small areas of the heart that cause the abnormal heart rhythm. This energy severs the connecting pathway of the abnormal rhythm.

Congestive Heart Failure

Congestive heart failure is a chronic and progressive reduction in the ability of the heart to pump blood. In the United States, approximately 550,000 new cases are diagnosed each year, and more than 287,000 people die each year from heart failure. The risk factors include advanced age, heart disease, hypertension, atherosclerosis, and diabetes.

Signs and symptoms include ankle swelling and shortness of breath with exertion. Severe signs and symptoms include shortness of breath at rest, fatigue and limb weakness, neck vein swelling, rales (wet, crackly lung noises), pulmonary edema (fluid in the lungs), cyanosis, and abnormal heart sounds. Diagnosis depends on physical exam, history, and imaging with ECG, chest x-ray, and echocardiography.

Treatment cannot cure or reverse congestive heart disease. Treatment can relieve symptoms and reduce stress on the heart. Treatment includes correction of the underlying causes, medications, restriction of salt and water intake, and modification of activities and lifestyle. Medication may include diuretics, medications that improve cardiac output, antihypertensives, antiarrhythmics, and medications that slow the heart rate. Congestive heart disease may be prevented by reducing risk factors for heart disease and by effectively treating heart disease, hypertension, and diabetes.

TABLE 6–4 Types and Etiology of Shock

Type of shock	Etiology
Cardiogenic	Cardiac arrhythmias Myocardial infarction
Hypovolemic	Hemorrhage Trauma Surgery Extensive burns
Anaphylactic	Allergic reaction
Septic	Toxins released by a bacterial infection
Neurogenic	Damage to the central nervous system

Shock

Shock is a life-threatening condition in which blood pressure drops too low to sustain life. Any condition that reduces the heart's ability to pump effectively or decreases venous return can cause shock. This low blood pressure results in an inadequate blood supply to the cells of the body. The cells can be quickly and irreversibly damaged and die. Major types of shock include cardiogenic, hypovolemic, anaphylactic, septic, and neurogenic shock. See Table 6–4 ► for types and etiology of shock.

Untreated shock is usually fatal. The prognosis depends on the underlying cause, preexisting illnesses, the time between onset and diagnosis, and rapidity of response to therapy.

Heart Disease in Infants and Children

Fetal circulation is anatomically different from postnatal circulation (Figure 6–20 ►). When a baby takes its first breath after birth, the newly expanded lungs initiate a switch from placental to pulmonary oxygenation of the blood. Cord clamping and removal of the placental circulation cause an increase in left-ventricular pressure. The decrease in right-atrial pressure and decrease in left-atrial pressure produce a closure

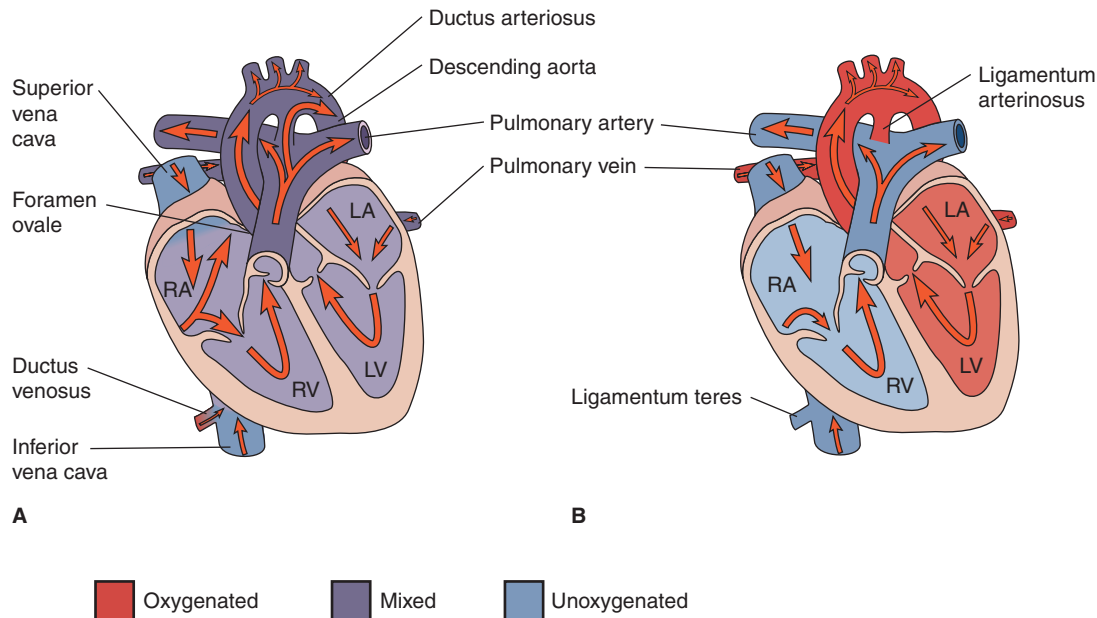


Figure 6-20 ► (A) Fetal circulation; (B) postnatal circulation.

of the foramen ovale. The newly expanded lungs favor the flow from the right heart via the pulmonary artery to the lungs as opposed to the ductus arteriosus. Closure of both the foramen ovale and the ductus arteriosus leads to the establishment of the postnatal circulation.

Congenital Heart Disease

The embryological development of the heart is complex, and many errors can occur during development. Genetic, environmental, and chromosomal changes may alter the development of the heart. Approximately 8 out of 1,000 infant births have some form of a congenital heart disease. Infants born to parents with a history of congenital heart disease are at a higher risk. Infants born with chromosomal abnormalities such as Down syndrome or Turner's syndrome have an increased risk for congenital heart disease. Maternal diabetes, congenital rubella, and maternal drug and alcohol abuse are also associated with congenital heart disease.

Tetralogy of Fallot Tetralogy of Fallot is one of the most serious of the congenital heart defects and

consists of four abnormalities: (1) ventricular septal defect, (2) pulmonary valve stenosis, (3) misplaced aorta that crosses the interventricular septum, and (4) hypertrophy of the right ventricle (Figure 6-21 ►).

Maternal risk factors during pregnancy that are associated with tetralogy of Fallot include a history of rubella, poor nutrition, alcohol abuse, history of diabetes, and maternal age over 40. Heredity may also play a role. Children with genetic disorders such as Down syndrome also may have congenital heart defects, including tetralogy of Fallot.

Symptoms of this condition include difficulty feeding; failure to gain weight; poor development; cyanosis that becomes more pronounced during feeding, crying, or defecation; fainting; sudden death; clubbing of the fingers; and squatting during episodes of cyanosis. Treatment requires surgical repair of the defects. More than one surgical procedure is required to increase blood flow to the lungs, patch the ventricular septal defect, open the narrowed pulmonary valve, and close any abnormal connections between the aortal and pulmonary artery. Tetralogy of Fallot cannot be prevented.

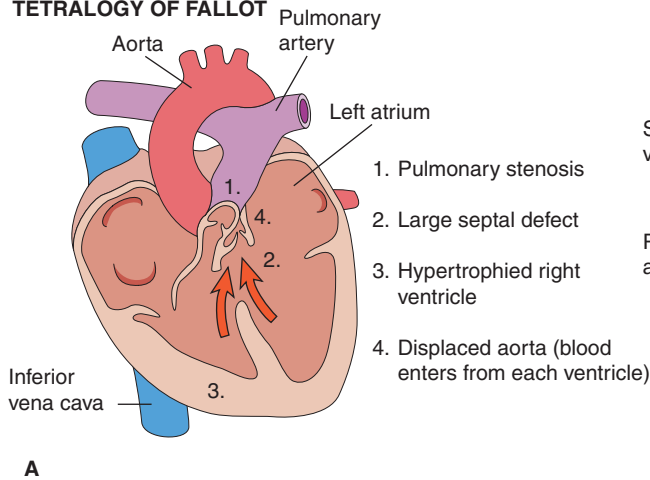
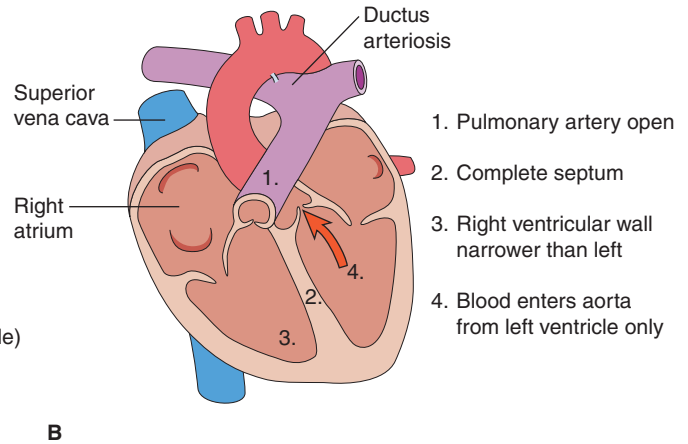
TETRALOGY OF FALLOT**NORMAL ANATOMY OF HEART**

Figure 6-21 ► (A) Tetralogy of Fallot; (B) normal anatomy.

Transposition of the Great Arteries In this condition, the aorta and the pulmonary artery connect to the wrong ventricle. The pulmonary artery is attached to the left ventricle, and the aorta is attached to the right ventricle; thus blood flow in the lungs and in the body occurs independently. Deoxygenated blood returns to the right heart and is pumped to the aorta, which pumps blood to the systemic circulation. The left heart receives blood from the lungs and then pumps the blood back to the lungs (Figure 6-22 ►).

Symptoms include cyanosis, shortness of breath, poor feeding, and clubbing of the fingers. If diagnosed prior to birth, medications

are administered that maintain a patent ductus arteriosus and allow mixing of oxygenated and deoxygenated blood. Corrective surgery within the first 2–3 weeks of life is essential for survival.

Septal Defects Septal defects may occur between the two atria—an atrial septal defect (ASD)—or between the ventricles—a ventricular septal defect (VSD). The prevalence of these defects is unknown because they may cause no symptoms. However, large atrial septal defects can overload the right ventricle and cause it to enlarge and weaken. Septal defects may be diagnosed by the presence of a heart murmur on physical examination (Figure 6-23 ►). Large defects require surgical repair. Septal defects cannot be prevented.

Patent Ductus Arteriosus At birth the ductus arteriosus normally closes. If the ductus remains open, blood intended for the body flows from the aorta to the lungs, overloading the pulmonary artery. Persistent increases in pulmonary arterial pressures can result in heart failure (Figure 6-24 ►). About 3,000 infants are diagnosed with patent ductus arteriosus (PDA) each year in the United States. It is more common in premature infants but does occur in full-term infants. Premature babies with PDA are more vulnerable to its effects.

A patent ductus can be treated medically with anti-inflammatory medications to close the PDA

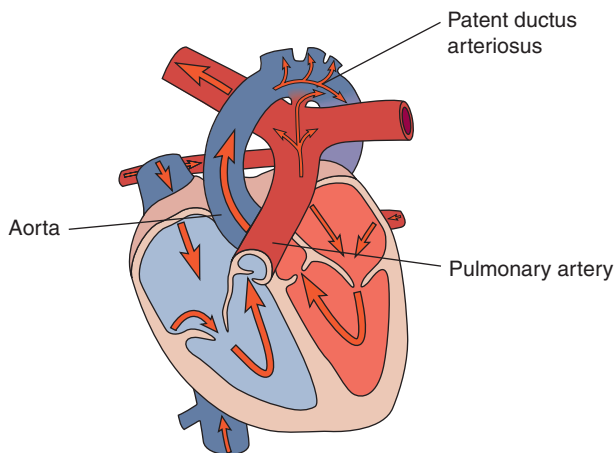


Figure 6-22 ► Transposition of the great arteries.

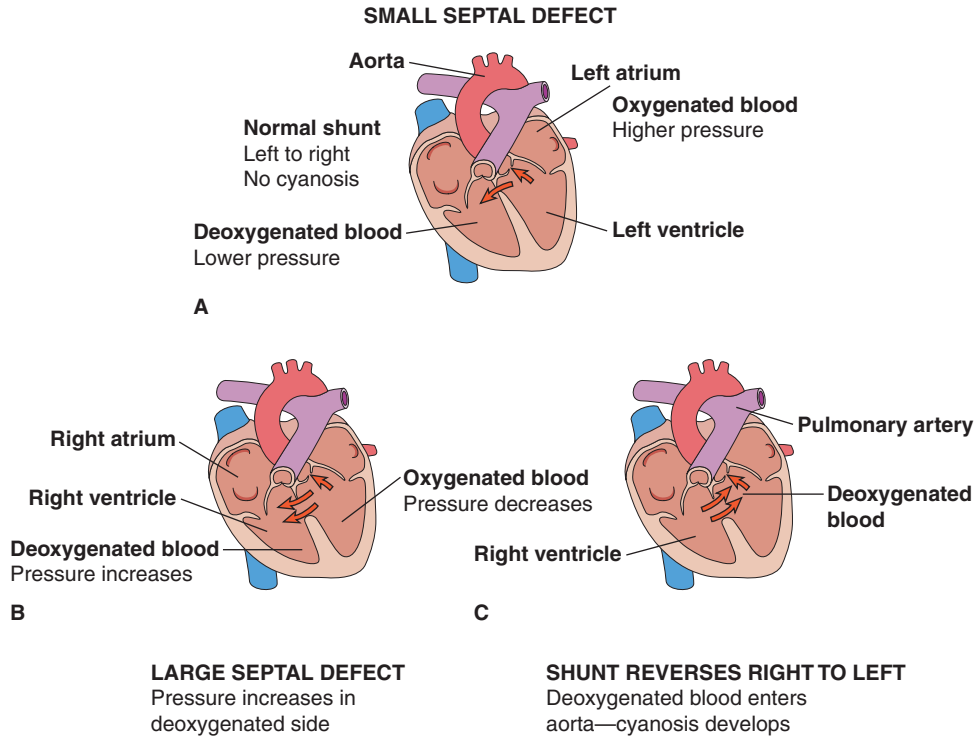


Figure 6–23 ► Effects of septal defects: (A) normal shunt; no cyanosis; (B) increased pressure in right ventricle; (C) shunt reversal; cyanosis develops.

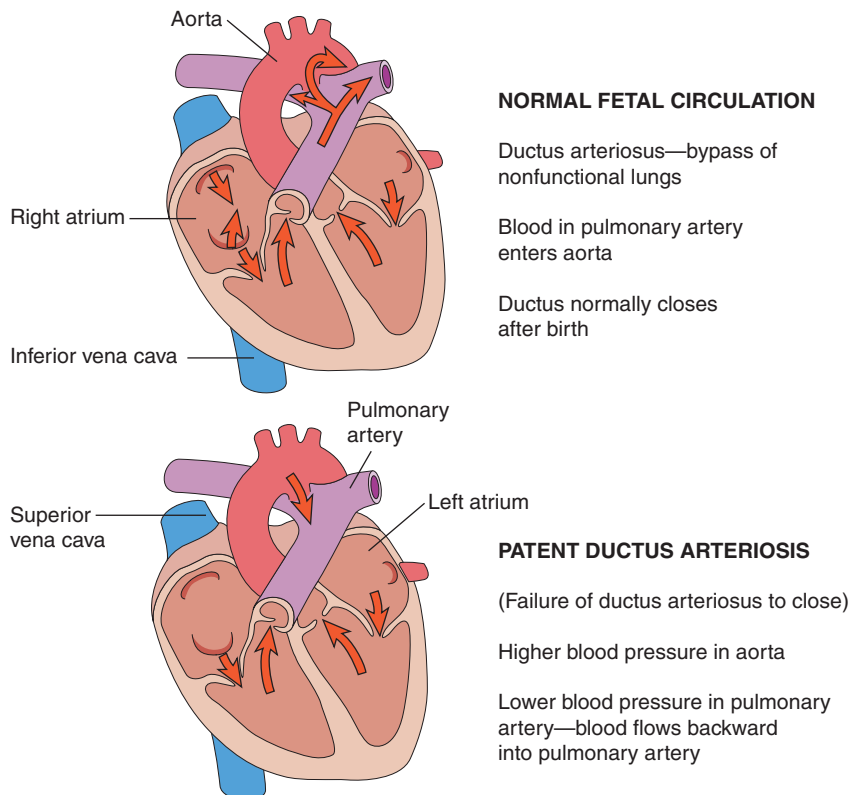


Figure 6–24 ► Patent ductus arteriosus.

and antibiotics to prevent endocarditis. If medication therapy fails, a transcatheter procedure or surgery may be performed to close the PDA.

Coarctation of the Aorta Coarctation of the aorta is a congenital narrowing of the aorta that can occur anywhere along its length (Figure 6–25 ►). Most commonly it occurs near the ductus arteriosus. A severe coarctation causes increases in resistance to the left ventricle and can eventually lead to heart failure.

Aortic coarctation occurs in approximately 1 out of 10,000 live births. It is often diagnosed in childhood, especially in cases where the narrowing is severe. In severe cases symptoms include dizziness, shortness of breath, and cold

legs. Diagnosis includes detection of a characteristic murmur, and depends on imaging with CT, echocardiography, and ultrasound. Treatment requires surgical enlargement of the aorta lumen.

Age-Related Disease

Cardiovascular disease is the leading cause of death in both men and women older than age 65. Hypertension occurs in one-half to two-thirds of people over age 65, and heart failure is the most frequently reported hospital discharge diagnosis among older adults in the United States.

Cardiovascular disease in older adults differs from that in younger persons. With age, systolic blood pressure and left ventricular mass progressively increase, and ventricular filling, heart rate and cardiac output, exercise capacity, and reflex responses of heart rate decrease. Cellular, enzymatic, and molecular changes in the arterial vessels lead to arterial dilation, thickening of the arterial intima, and vascular stiffness. With age, the cardiovascular system is less able to respond to increases in workload and stress.

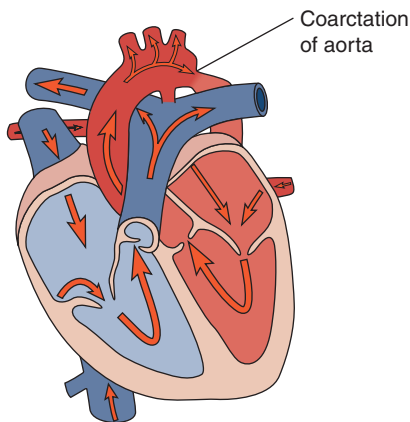


Figure 6–25 ► Coarctation of the aorta.

Resources

American Heart Association: www.americanheart.org

Centers for Disease Control: www.cdc.gov

National Institutes of Health: www.nhlbi.nih.gov/guidelines/cholesterol/atglance.htm

World Health Organization: www.who.int/en

Diseases at a Glance

Cardiac System

Disease	Etiology	Signs and Symptoms
Hypercholesterolemia	Genetic, lifestyle, obesity and diabetes, diet high in saturated fat	Elevated serum cholesterol
Atherosclerosis	Genetic, lifestyle, obesity and diabetes, diet high in saturated fat	Occlusion of an artery; symptoms depend on location of occlusion
Peripheral artery disease	Genetic, lifestyle, obesity and diabetes, diet high in saturated fat	Intermittent claudication, thinning of the skin of the lower leg, ulceration of the skin, gangrene can occur in advanced stages of this disease
Raynaud's disease	Unknown	Changes in skin color from pallor to cyanosis, sensation of cold, numbness, or tingling
Aortic aneurysm	Atherosclerosis, connective tissue disease, infections, trauma, inflammation	Usually asymptomatic until rupture
Arterial hypertension	Older age, sedentary lifestyle, overweight, excessive dietary salt intake, family history	Elevated blood pressure
Pulmonary arterial hypertension	Etiology unknown in many cases, ventricular septal defect, patent ductus arteriosus	Asymptomatic
Varicose veins	Long periods of standing, pregnancy	Swollen veins of the legs, knotty appearance under the skin
Chronic venous insufficiency	Deep vein thrombosis, obesity, smoking, pregnancy, sedentary lifestyle	Tissue congestion, edema, necrosis or skin atrophy, pain with walking
Venous thrombosis	Hypercoagulability, vascular trauma, surgery, immobilization	No symptoms in about 50% of individuals; symptoms of inflammation such as pain, swelling, deep muscle tenderness

Diagnosis	Treatment	Prevention
Blood test	Change in dietary habits, low-fat diet, cholesterol-lowering medication	Healthy lifestyle, diet and exercise, weight loss, low-fat diet
ECG, coronary angiography, blood tests, CT scan	Weight loss, exercise, control blood pressure with antihypertensive, reduce cholesterol with cholesterol-lowering medication	Healthy lifestyle, diet and exercise, weight loss, low-fat diet
Physical examination for ischemia, skin atrophy, pallor, absent pulses, ultrasound	Weight loss, exercise, control blood pressure with antihypertensive, reduce cholesterol with cholesterol-lowering medication	Healthy lifestyle, diet and exercise, weight loss, low-fat diet
Physical examination	Medications that improve circulation such as calcium channel blockers, alpha blockers, and vasodilators	Abstinence from cigarette smoking; protect extremities, ears, and nose from cold
Physical examination, ultrasound, echocardiography, CT scan, MRI	Surgery to repair aneurysm, control of blood pressure and atherosclerosis	Healthy lifestyle; control of hypertension, diabetes, and hypercholesterolemia
Blood pressure measurement via sphygmomanometer	Blood pressure-lowering medication, diet, weight loss, and exercise	Healthy lifestyle with proper diet and exercise; control of diabetes and hypercholesterolemia, weight loss
Echocardiography, pulmonary function test, lung scan, cardiac catheterization	Medications to lower pressure, oxygen, lung transplant	Etiology often unknown; surgical correction of ventricular septal defect and patent ductus arteriosus
Physical examination of the legs	Elastic bandages, support hose, walking, elevating the legs, surgical vein stripping, compression sclerotherapy	Weight loss, walking, elevation of the legs after long periods of standing
Doppler imaging studies	Diet, exercise, compression stockings, surgical bypass procedure	Weight loss, control of atherosclerosis and hypercholesterolemia, diabetes, exercise, healthy eating
Doppler imaging, physical exam	Blood thinning medication, surgery to remove the thrombus	Early ambulation following surgery or childbirth, compression stockings

Disease	Etiology	Signs and Symptoms
Coronary heart disease	Atherosclerosis, high blood pressure, diabetes, obesity, inactivity	Angina pectoris, palpitations, myocardial infarction
Myocarditis	Coxsackie virus, adenovirus, echovirus, HIV	Fever, chest pain, shortness of breath, tachycardia
Dilated cardiomyopathy	Infections, myocarditis, metabolic disorders, genetic disorders, immune disorders	Dyspnea, orthopnea, weakness, fatigue, ascites and peripheral edema
Hypertrophic cardiomyopathy	Unknown	Excessive ventricular growth
Restrictive cardiomyopathy	Endemic in parts of Africa, India, South and Central America, and Asia; amyloidosis	Dyspnea, orthopnea, peripheral edema, weakness, fatigue
Infective endocarditis	Rheumatic heart disease, valvular disease, degenerative heart disease, congenital heart disease, intravenous drug abuse, bacterial infections	Fever, chills, change in sound of an existing murmur, vegetative lesion on the heart valves
Rheumatic heart disease	Infection with group A hemolytic streptococci	Fever, inflammation of the joints, rash
Valvular heart disease		
Mitral stenosis	Rheumatic fever	Increased pressure in the heart, congestion of the veins, cyanosis, congestive heart failure
Mitral regurgitation	Mitral valve prolapse	Usually no symptoms
Aortic stenosis	Rheumatic fever, congenital defect, arteriosclerosis	Hypertrophy of the left ventricle, calcified deposits on the valve

Diagnosis	Treatment	Prevention
Physical exam, ECG, stress test, nuclear imaging, angiography	Angioplasty, coronary artery bypass surgery, blood pressure-lowering medication, blood thinners, diuretics, nitrates to stop chest pain, cholesterol-lowering medication, diet, exercise	Control of atherosclerosis; diet, exercise, weight loss if overweight or obese
Echocardiography, ECG, physical examination	Bed rest to prevent further myocardial damage, treatment of the viral infection	Unknown
Echocardiography, ECG, physical examination	Medications to treat symptoms, rest, heart transplant if severe	Unknown
Echocardiography, ECG, physical examination	Medications to treat symptoms and prevent sudden cardiac death	Unknown
Echocardiography, ECG, physical examination	Medications to treat symptoms	Unknown
Blood cultures, echocardiography, ECG, body temperature, blood cultures to identify bacterium	Antimicrobial therapy, surgery in severe cases to remove vegetations	Prompt treatment of bacterial infections, prophylactic antimicrobial therapy
Blood cultures, ECG, echocardiography	Antimicrobial therapy	Prompt treatment of bacterial infections, prophylactic antimicrobial therapy
ECG, echocardiography, phonocardiogram, cardiac catheterization	Valvuloplasty, surgical valve replacement	Prompt treatment of bacterial infections, prophylactic antimicrobial therapy, treatment of cardiac symptoms
ECG, echocardiography, phonocardiogram, cardiac catheterization	Surgery to replace valve	Prophylactic antimicrobial therapy prevents bacteria from colonizing defective valve
ECG, echocardiography, phonocardiogram, cardiac catheterization	Surgery to replace valve	Prophylactic antimicrobial therapy prevents bacteria from colonizing defective valve

Disease	Etiology	Signs and Symptoms
Aortic regurgitation	Endocarditis, dilated aorta	Dilation of the ventricle; backflow of blood into the left ventricle, decreased diastolic pressure, symptoms of heart failure
Cardiac arrhythmias		
Supraventricular	Abnormalities in the SA node, AV node, and junctional tissue of the heart; myocardial infarction; hypertension; atherosclerosis; metabolic disease; smoking; and drug abuse	Tachycardia, bradycardia, heart block, syncope, edema, shortness of breath
Ventricular	Generated by abnormalities in the ventricular conduction system and in the ventricle, myocardial infarction, hypertension, atherosclerosis, metabolic disease, smoking, and drug abuse	Tachycardia, bradycardia, heart block, syncope, edema, shortness of breath
Congestive heart failure	Complication of most forms of heart disease	Shortness of breath, fatigue, edema
Shock	Heart disease, hemorrhage, trauma, surgery, allergic reaction, release of bacterial toxins, damage to the central nervous system	Drop in blood pressure too low to sustain life
Congenital heart disease		
Tetralogy of Fallot	Maternal history of rubella, overuse of alcohol, maternal history of diabetes or poor prenatal nutrition; infants born with Down syndrome	Difficulty feeding, failure to gain weight, poor development, cyanosis, fainting, sudden death
Transposition of the great arteries	Unknown	Cyanosis, shortness of breath, poor feeding

Diagnosis	Treatment	Prevention
ECG, blood pressure check, echocardiography, phonocardiogram, cardiac catheterization	Surgery to replace valve	Unknown
ECG, blood pressure check, echocardiography, phonocardiogram, cardiac catheterization	Anti-arrhythmic medications	Prevention of heart disease
ECG, blood pressure check, echocardiography, phonocardiogram, cardiac catheterization	Anti-arrhythmic medications	Prevention of heart disease
Physical examination, ECG, x-ray, echocardiography, blood pressure	Medication therapy includes diuretics, antihypertensive, anti-arrhythmic medications, medications that improve cardiac output, bed rest	Treatment of underlying heart disease
Physical exam, medical history	Rapid administration of fluids to increase blood pressure, medication to increase heart rate	Fluid replacement during surgery, prompt treatment of severe bacterial infections, prompt treatment of allergic reactions, blood transfusion in cases of severe blood loss
ECG, blood pressure check, echocardiography, phonocardiogram, cardiac catheterization	Corrective surgery	Unknown
ECG, blood pressure check, echocardiography, cardiac catheterization	Administration of prostaglandins at birth to maintain patent ductus arteriosus until corrective surgery can be achieved	Unknown

Disease	Etiology	Signs and Symptoms
Septal defects	Unknown	Heart murmur, a interventricular septal defect causes increased blood flow to the lungs
Patent ductus arteriosus	Unknown	Initially asymptomatic; increased pressure in the lungs can lead to pulmonary hypertension
Coarctation of the aorta	Unknown	Increased pressure in the left ventricle, symptoms of heart failure in severe narrowing

Diagnosis	Treatment	Prevention
ECG, blood pressure check, echocardiography, phonocardiogram, cardiac catheterization	Large defects require surgical correction	Unknown
ECG, blood pressure check, echocardiography, cardiac catheterization	Antibiotics to prevent endocarditis, anti-inflammatory medication to close the patent ductus	Unknown
ECG, blood pressure check, echocardiography, cardiac catheterization, Doppler ultrasound	Surgical correction	Unknown

Interactive Exercises

Cases for Critical Thinking

1. The paramedics are called for a 59-year-old male who is experiencing severe chest pain while playing golf. What type(s) of heart or vascular disease should be considered in this patient?
2. A 65-year-old female reports to her physician with shortness of breath, feeling of faintness, dizziness, and productive cough, all of which have persisted over the past 2 months. Upon examination, the physician reports a blood pressure of 90/50 mm Hg, congestion in the lungs, and abnormal heart sounds. What type of heart diseases should be considered in this patient?
3. A 30-year-old obese female complains of pain with walking. The patient has a history of smoking cigarettes and is a “borderline diabetic.” Explain the role of cardiovascular risk factors for cardiovascular diseases for this patient.

Multiple Choice

1. Syncope is _____.
 - a. hypertension
 - b. shortness of breath
 - c. lightheadedness
 - d. fluid retention
2. Diastole is the _____.
 - a. filling phase of the heart
 - b. contracting phase of the heart
 - c. alternation between relaxation and excitation of the heart
 - d. impulse of the heart
3. The major cholesterol carrier in the blood is _____.
 - a. HDL
 - b. triglycerides
 - c. blood
 - d. LDL
4. Blockage of the _____ can reduce blood supply to the brain, causing a stroke.
 - a. pulmonary artery
 - b. carotid artery
 - c. aorta
 - d. coronary artery
5. The most common cause of an aortic aneurysm is _____.
 - a. atherosclerosis
 - b. hypertension
 - c. enlarged artery
 - d. embolism
6. Use of a balloon-tipped catheter to crush plaque in a coronary artery is called _____.
 - a. defibrillator
 - b. angioplasty
 - c. transcatheter procedure
 - d. echocardiography
7. The mitral valve is located _____.
 - a. between the right atrium and the right ventricle
 - b. between the left atrium and the left ventricle
 - c. in the atria
 - d. in the ventricle
8. The pacemaker of the heart is the _____.
 - a. atrioventricular valve
 - b. His-Purkinje fibers
 - c. ventricle
 - d. sinoatrial node

9. An inflammatory disease of the heart muscle is _____.
 - a. myocarditis
 - b. pericardial disease
 - c. cardiomyopathy
 - d. coronary heart disease
10. Rheumatic heart disease is also known as a(n) _____ disease because it results from a reaction between bacterial antigens and the patient's antibodies.
 - a. hemolytic
 - b. vegetative
 - c. autoimmune
 - d. tricuspid valve

True or False

- _____ 1. Infants born with chromosomal abnormalities have a higher risk for congenital heart disease.
- _____ 2. Salt and water restriction is one form of treatment for congestive heart failure.
- _____ 3. An interruption of the flow of impulses through the conduction system is called bradycardia.
- _____ 4. In ventricular fibrillation, the heart quivers and is able to maintain cardiac output.
- _____ 5. In mitral valve stenosis, delivery of blood via the pulmonary veins to the right atrium is impaired.
- _____ 6. Cardiomyopathy may be a congenital disease of the heart.
- _____ 7. The most common cause of infective endocarditis is a bacterial infection.
- _____ 8. The early form of fatty deposits leading to atherosclerosis is a fatty streak.
- _____ 9. Intact aortic aneurysms typically cause symptoms.

Fill-Ins

1. The most common cause of chronic venous insufficiency is deep vein _____.
2. More than 90% of patients with coronary heart disease have _____.
3. _____ is associated with reduced heart-filling pressure and endocardial scarring.
4. _____ refers to a narrowing of the heart valves.
5. The predominant cause of mitral stenosis is _____.
6. Backflow of blood in aortic regurgitation causes the _____ to dilate.
7. An _____ is an abnormal or uncoordinated heartbeat.
8. A machine called a _____ delivers electrical shocks and is used to reestablish normal heart rhythm.
9. The most serious type of fibrillation affects the _____.
10. The _____ arteries provide the heart muscle with blood and oxygen.

Chapter 7

Diseases and Disorders of the Blood

Learning Objectives

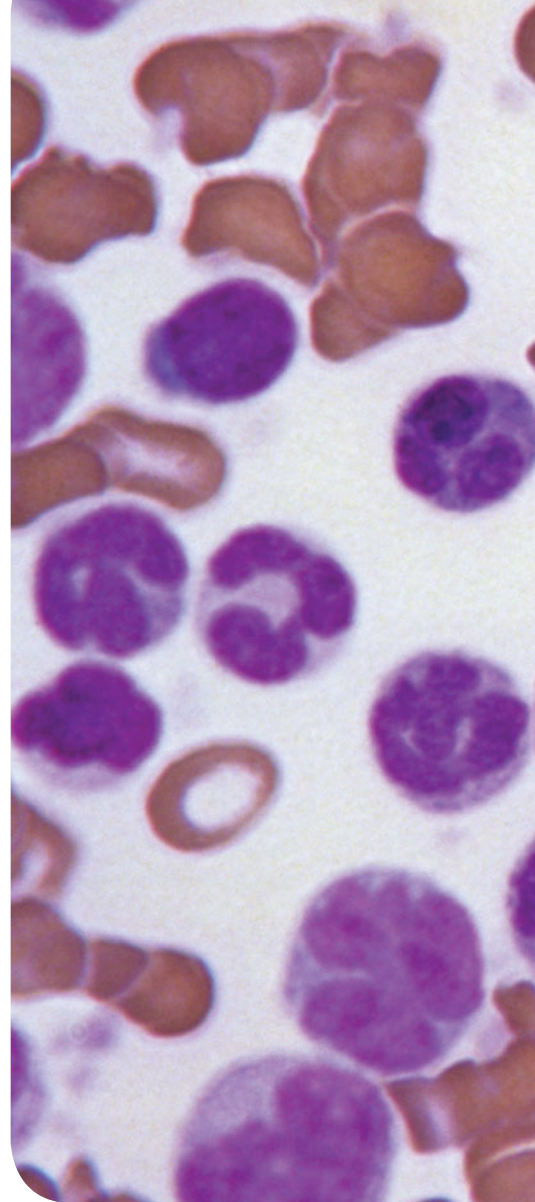
After studying this chapter, you should be able to

- Distinguish between formed elements and plasma
- Describe the function of red blood cells, white blood cells, and platelets
- Identify the characteristics, diagnosis, and treatments of the main types of anemia
- Identify the characteristics, diagnosis, and treatments of hemoglobinopathies
- Identify the characteristics, diagnosis, and treatments of the main types of clotting disorders
- Identify the characteristics, diagnosis, and treatments of selected inherited disorders of the blood
- Identify the characteristics, diagnosis, and treatments of disorders affecting leukocytes

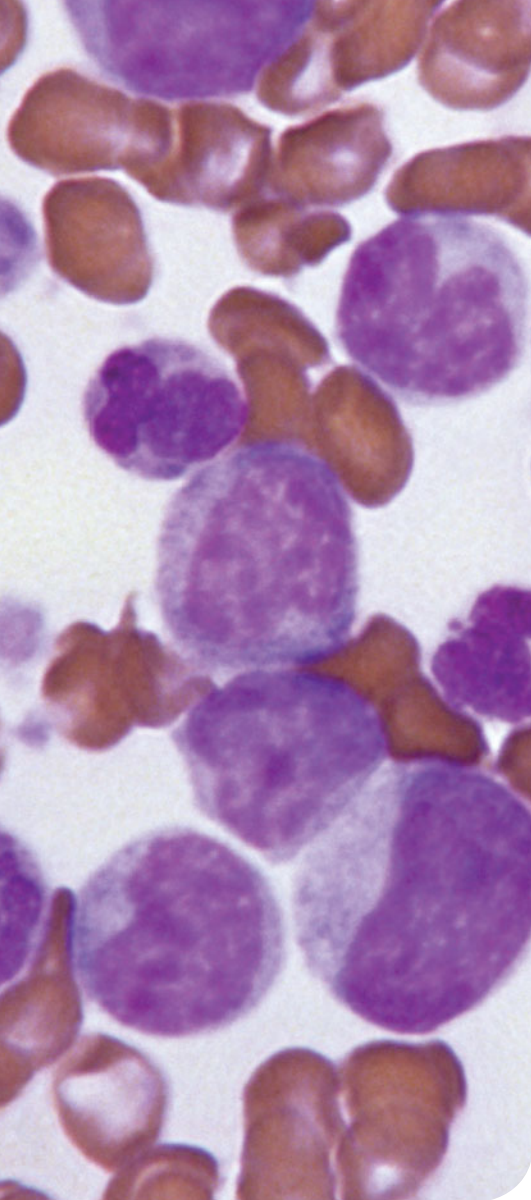
Fact or Fiction?

Blood is 90% water.

False: Blood is a viscous fluid, but it does not contain that much water. Blood consists of 45% cells and platelets and 55% plasma. The plasma contains about 90% water and 10% dissolved substances and proteins.



Peripheral blood smear showing blast crisis of chronic myelogenous leukemia. (Courtesy of the Centers for Disease Control and Prevention/Stacy Howard, 1994)



Disease Chronicle

Clinical Use of Leeches

The first clinical use of medicinal leeches (*Hirudo medicinalis*) was recorded approximately 2,500 years ago. This small blood-sucking invertebrate produces a bleeding wound as it feeds on a host's blood. Upon biting a host, the leech releases an anticoagulant, a local vasodilator, and local anesthetic. These substances allow continued bleeding up to 10 hours after the animal has detached.

Today, medicinal leeches are used to restore venous circulation following surgical reattachment of severed appendages such as fingers or toes. Severed blood vessels are often so damaged that they lack the ability to clear blood. Leeches apply enough suction and anticoagulants to initiate blood flow when the patient's own blood supply isn't adequate. Research indicates that after about 3–5 days, new vessels develop near the surgical site and restore effective venous drainage.

Introduction

Blood serves as the body's transportation system, carrying oxygen, glucose, and waste products around the body. Therefore, impaired circulation or abnormalities in the structure or function of the blood's components can have systemic, devastating effects. This chapter examines common diseases and disorders of the blood.

Anatomy and Physiology Review

Blood is the medium for transporting oxygen, carbon dioxide, water, nutrients, proteins, hormones, and cells throughout the body. Blood also transports waste products to excretory organs of the body. Blood consists of a fluid portion, called plasma, and formed elements, which include red blood cells, white blood cells, and platelets.

Plasma consists of mostly water, which carries nutrients, wastes, ions, hormones, clotting factors, albumin, and antibodies. These substances circulate in the blood throughout the body. Thus, clotting factors are available to initiate clots wherever blood loss may occur, antibodies can be delivered to nearly any site of infection, and hormones can travel from their origin to any organ in the body. Plasma contains the protein albumin, which promotes the blood's ability to hold water and maintain pressure inside the blood vessels.

Erythrocytes, or red blood cells (RBCs), make up about half of the blood's volume. Red blood cells are the most abundant cells in the human body. Erythrocytes normally number about 5 million/mm³ in males and about 4.5 million/mm³ in females. Unlike other cells in the human body, mature red blood cells have no nucleus. Specialized for carrying oxygen, red blood cells are biconcave sacs filled with an iron-rich oxygen carrying protein called hemoglobin.

Hemoglobin is the most important component of red blood cells. It is composed of a protein called **globin** and an iron-containing **heme** molecule. In the lungs, hemoglobin binds to oxygen, becoming oxyhemoglobin. These oxygenated red blood cells are then transported to the body's tissues, where oxyhemoglobin releases oxygen and picks up carbon dioxide, becoming carboxyhemoglobin.

With no nucleus, red blood cells do not grow or repair themselves, so they have a brief lifespan of

only 120 days. As old red blood cells are removed from the body by the liver and the spleen, new erythrocytes are continually produced in the red marrow of the bones such as the vertebrae and the body of the sternum. The process of red blood cell formation, called **erythropoiesis**, is regulated by the hormone **erythropoietin**. Red blood cell production begins with large nucleated stem cells that progress through many stages before emerging as mature red blood cells. In the process, hemoglobin accumulates within the cytoplasm and the nucleus disappears. Mature red blood cells emerge from the bone marrow as reticulocytes.

Leukocytes, or white blood cells, include **neutrophils**, **eosinophils**, **basophils**, **monocytes**, and **lymphocytes** (Figure 7-1 ►). White blood cells are produced in the bone marrow from their respective stem cells. The primary function of leukocytes is to defend tissues against infections and foreign substances. Abnormal numbers, inherited acquired defects, and neoplastic alterations in the white blood cells result in disease and disability.

Platelets are produced in the bone marrow and are essential for blood clotting. Various clotting factors are formed in the liver, enter the blood, and become active in response to injury. During

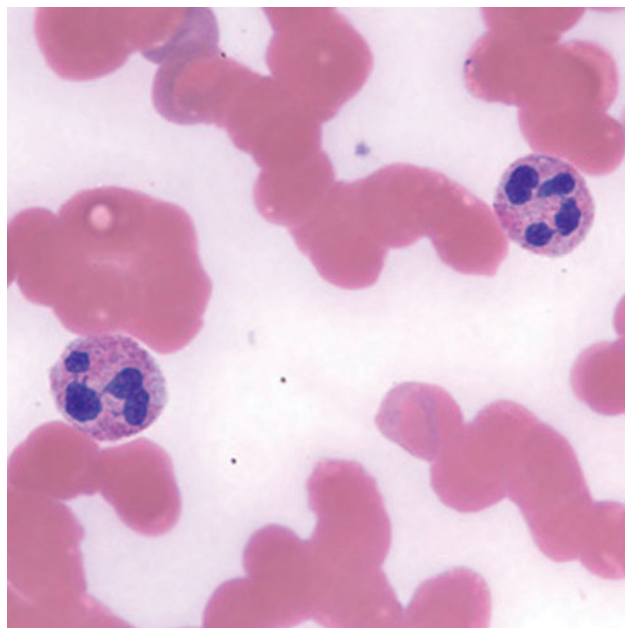


Figure 7-1 ► Neutrophils in a normal blood smear.

clot formation, platelets become sticky and trigger the deposition of an insoluble clotting protein called fibrin. Platelets and fibrin form a dense mesh at a wound, preventing blood loss. Vitamin K is required for the synthesis of the prothrombin and thrombin clotting factors.

Diagnostic Tests and Procedures

Blood tests are diagnostic for systemic diseases as well as specific blood disorders. Blood tests measure total blood counts (red blood cells, white blood cells, and platelets), hemoglobin, hematocrit, serum chemistry, and enzyme and hormone levels within the body. Differential blood analysis provides qualitative information such as size, shape, and ratio of one cell type to another.

A bone marrow smear is used to diagnose malignant blood disorders and increases or decreases in blood counts. Bone marrow samples are obtained by needle aspiration of the bone marrow from the bone marrow cavity. Bone marrow analysis provides information on the function of the bone marrow and the qualitative characteristics of stem cells that give rise to all blood cells.

Anemia

Anemia is a condition of an abnormally low number of red blood cells that leads to reduced delivery of oxygen and nutrients to the tissues. Causes include hemorrhage, excessive destruction of red blood cells, nutritional deficiency, and chronic disease.

The symptoms of anemia are due to tissue **hypoxia**, or lack of oxygen. Acute hemorrhage results in rapid appearance of symptoms and, if severe, many result in shock. Most patients develop anemia slowly and have few symptoms initially. Usual complaints are fatigue, decreased tolerance for exercise, dyspnea, and palpitations. In physical examination, the major sign of anemia is pallor. Jaundice and enlargement of the spleen occurs with anemia caused by **hemolysis**, or red blood cell death. Cardiac signs of anemia include tachycardia, or rapid heartbeat, and heart murmurs.

The clinical diagnosis of anemia requires a microscopic examination and analysis of red blood cells. A detailed medical history,

including information on dietary habits, family history of anemia, and information regarding the patient's medical problems, provide data for the diagnosis.

Iron-Deficiency Anemia

Iron-deficiency anemia describes anemia in which there is evidence of iron deficiency. Iron deficiency is the leading cause of anemia worldwide. The prevalence of iron-deficiency anemia is greatest among preschool children and adolescent and adult females.

Risk factors for iron-deficiency anemia include excessive blood loss, menstruation, pregnancy, and rapid growth during adolescence. In these cases, the demand for iron outstrips the supply. Normally iron is replaced by dietary intake or supplementation. The amount of iron required in the diet is approximately 1.0–1.4 mg of elemental iron per day, which is easily achieved in the United States, where the average iron intake in an adult male is 15 mg/d and 11 mg/d for females.

The first stage in the development of iron-deficiency anemia is a negative iron balance, in which the demands for iron exceed the body's ability to absorb iron from the diet. This stage can result from a number of physiological

Prevention PLUS!

Anemia and Vegetarians

Are you vegetarian? Vegetarians are at risk for iron-deficiency anemia and pernicious anemia. They can prevent these by ensuring a diet rich in iron and vitamin B₁₂. To obtain iron in a vegetarian diet, eat green leafy vegetables, dried beans, whole grains, and cereals, pasta, and rice enriched with iron. Other sources of iron include dried fruits, pumpkin seeds, and blackstrap molasses. To ensure sufficient dietary vitamin B₁₂, eat cereals, pasta, grains, and soy or rice milk fortified with vitamin B₁₂. Other sources of vitamin B₁₂ include nutritional yeast and dietary supplements rich in B vitamins.

Think Critically

1. Why are vegetarians at risk for anemia?
2. Is it easier to obtain iron from meat or from vegetables?
3. Should children eat vegetarian diets?

problems, including blood loss, pregnancy, rapid growth spurts in children and adolescents, and inadequate dietary intake. During pregnancy, the demands for red blood cell production by the fetus exceed the mother's ability to provide iron. During the first stage of iron deficiency, anemia may not be present.

The second stage of iron-deficiency anemia occurs when the iron stores in the body become depleted. At this point the synthesis of hemoglobin becomes impaired. As iron deficiency progresses, the red blood cells lose their shape and appear cigar- or pencil-shaped upon microscopic analysis on a peripheral blood smear (Figure 7-2 ▶).

Signs and symptoms of iron deficiency include weakness and fatigue. Mild to moderate iron deficiency can affect cognitive performance, behavior, and growth in preschool- and school-age children. Iron deficiency during pregnancy increases overall infant mortality or death.

The most frequent cause of iron deficiency in men and postmenopausal women is gastrointestinal bleeding. In premenopausal women, iron deficiency may arise with menstruation and during pregnancy. Iron deficiency in young children occurs when intake of iron does not keep pace with rapid growth and development. Malabsorption syndrome and chronic diseases of the intestines or stomach may also cause iron deficiency.

The treatment for iron deficiency is oral iron supplementation. Injectable iron supplements are available for individuals with malabsorption or those who cannot tolerate oral supplements. Prevention includes compensating for risk factors by choosing iron-rich meals and iron supplementation if necessary.



Figure 7-2 ▶ Iron-deficient red blood cells. (Joaquin Carrillo Farga/Photo Researchers, Inc.)

Anemia of Chronic Disease

Anemia of chronic disease occurs in patients as a result of chronic inflammatory, infectious, and autoimmune diseases. The etiology of anemia of chronic disease most often is a defect in erythropoiesis, the production of red blood cells.

The severity of the anemia of chronic disease depends on the primary condition. For example, patients with rheumatoid arthritis or tuberculosis may have severe anemia from depletion of iron stores. Moderate anemia is associated with cardiac conditions such as angina pectoris and exercise intolerance.

Anemia of chronic disease may resolve if the underlying disease is treated. In some cases,

Promote Your Health

Prevent Iron-Deficiency Anemia

The most common cause of anemia is iron deficiency. Those most at risk are infants, young children, adolescent girls and women of childbearing age, and pregnant women. Sufficient iron can be obtained in a diet that includes fruits, vegetables, whole grains, milk, lean meats, fish, dry beans,

eggs, and nuts. The iron in meat and fish is heme iron, which is readily absorbed. The iron in plant-based foods is nonheme. To enhance the absorption of nonheme iron from the diet, foods rich in vitamin C should be eaten in the same meal.

therapy with erythropoietin, a hormone secreted by the kidney that stimulates synthesis of red blood cells, will stimulate production of red blood cells.

Anemia of Renal Disease

Chronic kidney failure or **renal failure** results in moderate to severe anemia, depending on the severity of renal disease. This type of anemia is caused by the kidney's failure to produce adequate amounts of erythropoietin. Assessment of iron status provides information to distinguish the anemia of renal disease from iron-deficiency anemia. Patients with anemia of renal disease usually have normal serum iron.

Megaloblastic Anemia

The megaloblastic anemias are caused by impaired DNA synthesis. Megaloblastic red blood cells tend to be large and contain an increased ratio of RNA to DNA. The underlying cause of impaired erythropoiesis in megaloblastic anemia is a deficiency in vitamin B₁₂ and/or folic acid, which are required for red blood cell production. We examine each of these deficiencies next.

Vitamin B₁₂-Deficiency Anemia

Vitamin B₁₂ is a complex compound that cannot be synthesized by the human body and must be supplied by the diet. The minimum daily requirement for vitamin B₁₂ is about 2.5 micrograms. Normally about 2 micrograms of vitamin B₁₂ are stored in the liver and another 2 micrograms are stored elsewhere in the body. It would take approximately 3–6 years for a normal individual to become deficient in vitamin B₁₂ if absorption were to cease abruptly.

Vitamin B₁₂-deficiency anemia, or **pernicious anemia**, is caused by inadequate absorption or intake of vitamin B₁₂, or a deficiency in a protein called **intrinsic factor**. Intrinsic factor is produced in the stomach and is essential for the absorption of vitamin B₁₂ from the small intestine. Without vitamin B₁₂ and intrinsic factor, the membranes of immature red blood cells rupture easily within the blood. The result is anemia and a reduced oxygen-carrying capacity.

Causes of pernicious anemia include inadequate diet, impaired absorption, increased requirements, or increased excretion of vitamin B₁₂. Principal dietary sources of vitamin B₁₂ include animal food products. Vegetarians who eat no animal products develop pernicious anemia unless they consume vitamin B₁₂ supplements. Abnormal bacterial growth in the small intestine and bowel disorders induce pathological changes that either impair absorption or increase elimination of vitamin B₁₂. Removal of the stomach or the bowel reduces the availability of intrinsic factor and limits absorption of vitamin B₁₂.

Symptoms of pernicious anemia include abdominal distress, nausea and vomiting, and burning of the tongue. Neurological disturbances include numbness, weakness, and yellow and blue color blindness.

Vitamin B₁₂ supplementation reverses the effects of pernicious anemia. Because people with pernicious anemia cannot absorb vitamin B₁₂, it must be replaced by injection. Vitamin B₁₂ supplementation is required for strict vegetarians and for those with chronic bowel disorders or individuals who have had their stomach or bowel partially or fully removed.

Folic Acid-Deficiency Anemia

Folic acid is synthesized by many different types of plants and bacteria. Fruits and vegetables constitute the primary dietary source of folic acid. The minimum daily requirement is normally about 50 micrograms, but this may be increased during periods of enhanced metabolic demand such as pregnancy.

Healthy Aging

Preventing Vitamin B₁₂ Deficiency

The ability to absorb vitamin B₁₂ declines with age, so older adults are at risk for vitamin B₁₂ deficiency. However, the ability to absorb vitamin B₁₂ in its crystalline form remains intact. Fortunately, fortified cereals and some dietary supplements contain the crystalline form of B₁₂, making it relatively easy for older adults to prevent vitamin B₁₂ deficiency.

Normally individuals have about 5–20 micrograms of folic acid in various body stores, half of which is in the liver. Because the body's stores are low, folic acid deficiency can occur within months if dietary intake or intestinal absorption is decreased.

Folic acid–deficiency anemia is common in the Western world, where consumption of raw fruits and vegetables is low. Folic acid absorption can be impaired by inflammation of the bowel, as in Crohn's disease, and adverse effects of certain medications. Pregnant and lactating females, those who abuse alcohol, and individuals with kidney disease are susceptible to folic acid–deficiency anemia.

Folic acid–deficiency anemia can be detected by measurement of serum folic acid levels. Oral folic acid supplementation replaces folic acid and meets the requirements for those with increased metabolic demands.

Hemolytic Anemia

Hemolytic anemia is a reduction in circulating red blood cells that is caused by accelerated destruction of red blood cells. Inherited abnormalities such as hemoglobin defects, enzyme defects, and membrane defects impair optimal red blood cell survival. Infectious agents, certain medications, and immune disorders may also reduce red blood cell survival.

Significant red blood cell destruction produces symptoms similar to those of other anemias. Unlike other anemias, hemolytic anemia produces increased serum levels of **bilirubin** that result from the degradation of heme in destroyed red blood cells. Accumulation of bilirubin causes a jaundiced or yellow-orange appearance in the tissues, urine, and feces.

Treatment of hemolytic anemia depends on the underlying etiology.

Splenectomy, or removal of the spleen, is recommended in cases of inherited causes of hemolytic anemia. Removal of the spleen decreases the risk of gallstones, severe episodes of hemolysis, and pathological changes to the bone marrow. Blood transfusions are recommended in cases of severe blood loss such as trauma. Infectious causes can be adequately treated with antibiotics and supportive therapies. Similarly, immune disorders can be treated with various immune suppressive

therapies. Medications known to trigger hemolysis will be discontinued and rarely restarted in patients who develop hemolytic anemia.

Hemoglobinopathies

The **hemoglobinopathies** are disorders affecting the structure, function, or production of hemoglobin. These conditions are usually inherited and vary in severity of symptoms. The most common hemoglobinopathies are sickle cell anemia and thalassemia.

Sickle Cell Anemia **Sickle cell anemia** is a genetic disorder marked by severe hemolytic anemia, painful episodes called sickle cell crises, and increased susceptibility to infections. Although it is inherited, there are two forms of the disease. Those who are heterozygotes (having inherited the gene from just one parent) have sickle cell trait, a mild disease. Those who are homozygotes (having inherited two genes, one from each parent) have the severe form known as sickle cell anemia. Approximately 10% of African Americans have the sickle cell trait.

In sickle cell disease, red blood cells contain an abnormal form of hemoglobin, or hemoglobin S. As the red blood cell deoxygenates, hemoglobin S cross-links with other hemoglobin S molecules and long crystals develop. Crystals continue to form as oxygen is released, and the red cells assume a sickled shape.

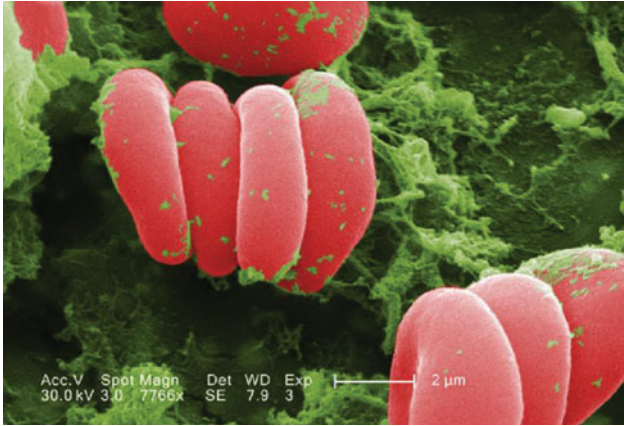
Sickled red blood cells are inflexible and rigid and obstruct small arterioles and capillaries, leading to pain and ischemia. Sickled cells are also more fragile than normal, leading to **hemolysis**. Patients with sickle cell disease suffer from hemolytic anemia. Tissue death caused by ischemia causes great pain and may lead to organ failure with repeated hemolytic episodes.

Sickle cell disease is diagnosed on the basis of symptoms and by microscopic examination of red blood cells. The diagnosis is usually established in childhood, and genetic counseling is recommended for parents.

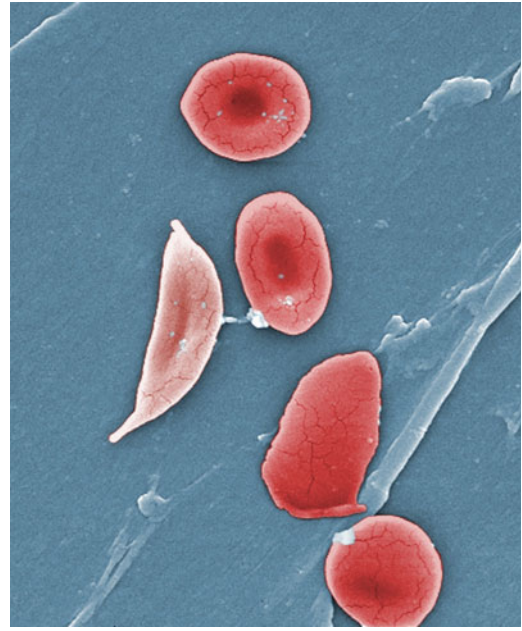
Sickle cell anemia cannot be cured. Patients with sickle cell disease require continuous care. Treatment is aimed at preventing sickle cell hemolysis, controlling the anemia, and relieving painful symptoms. Pain is treated with analgesics. Blood transfusions and fluid replacement

Side By Side

Sickle Cell Anemia



► Normal erythrocytes are biconcave discs that can stack like coins and pass easily through capillaries. (Centers for Disease Control and Prevention/Janice Haney Carr)



► Sickle cells. (Centers for Disease Control and Prevention/Janice Haney Carr)

expand blood volume and improve circulation in blocked blood vessels.

Thalassemia **Thalassemia** is an inherited blood disorder in which there is deficient synthesis of one or more of the protein chains required for proper formation and optimal performance of the hemoglobin molecule. Several different categories of thalassemia produce mild to severe symptoms.

Thalassemias are the most common genetic disorders in the world, affecting nearly 200 million people worldwide. About 14% of African Americans are carriers for alpha thalassemia. Beta thalassemia occurs among 10–15% of people from Mediterranean countries and Southeast Asia. About 1,000 severe cases occur annually in the United States.

The most severe forms of thalassemia produce severe, life-threatening anemia, bone marrow

hyperactivity, enlargement of the spleen, growth retardation, and bone deformities. Blood transfusions are required, and life expectancy is reduced.

The diagnosis of most forms of thalassemia is made during childhood as children present with symptoms of severe anemia. The red blood cells in patients with thalassemia resemble red blood cells of severe iron-deficiency anemia. Diagnosis of thalassemia syndromes in a fetus is currently available through examination of fetal DNA obtained by amniocentesis or chorionic villus biopsy.

Polycythemia Vera

Polycythemia describes a condition in which red blood cell mass is increased. This condition is categorized as relative or absolute. In relative polycythemia, the increase in red blood cell mass is due to a loss of plasma volume without

a corresponding decrease in red blood cells. This may occur in cases of dehydration or excessive use of diuretics. Absolute polycythemia, also known as **polycythemia vera**, is a rise in red blood cell mass accompanied by an increase in white blood cells and platelets in the absence of a recognizable physiological stimulus.

Polycythemia vera is most commonly seen in men between the ages of 40 and 65 years. The etiology of this disease is unknown, although chromosomal abnormalities have been documented in some cases.

Signs and symptoms of this disease result from increased viscosity of the blood. Uncontrolled growth of the blood cells can lead to neurologic symptoms such as dizziness, headaches, and visual disturbances. Hypertension accompanies increases in red blood cell mass. Because of the increased concentration of blood cells, a patient may experience itching and pain in the fingers and toes. Thromboembolism with death may occur in severe, undiagnosed cases of polycythemia vera.

Polycythemia vera is treated by decreasing the thickness of the blood. This can be done by intravenously removing blood to reduce red blood cell volume. Chemotherapeutic agents may help suppress the production of all blood cells by the bone marrow. The symptoms of the disease can be managed with administration of pain medications, and antihistamines can help relieve the discomfort associated with itching.

Disorders of Hemostasis

Disorders of hemostasis, commonly known as bleeding disorders, include a range of medical problems that lead to poor blood clotting and continuous bleeding. Platelets and the clotting factors prothrombin, thrombin, vitamin K, and calcium are essential for **hemostasis**, or the arrest of bleeding. Bleeding disorders result from abnormal platelet function or number, vitamin K deficiency, or clotting factor deficiencies.

Thrombocytopenia

An abnormally small number of circulating platelets is the condition of **thrombocytopenia**.

Thrombocytopenia is the most common bleeding problem among hospitalized patients. It results from impaired production or increased destruction of platelets. A common cause of thrombocytopenia is cancer chemotherapy or radiation treatment, which suppresses platelet formation by destroying the bone marrow.

Regardless of cause, thrombocytopenia makes the body vulnerable to prolonged bleeding. Even minor trauma can trigger serious bleeding. Spontaneous hemorrhages are often visible on the skin as small, flat, red spots called **petechiae**, or as larger purplish patches called **ecchymoses** (Figure 7-3 ►). Spontaneous hemorrhages may also occur in the mucous membranes of the mouth and internal organs.

Careful microscopic examination of the blood is essential in diagnosing thrombocytopenia. Bone marrow examination is useful for diagnosing impairments in the synthesis of platelets.

Thrombocytopenia can usually be corrected by treating the underlying cause. Preventative measures such as bed rest to avoid accidental trauma are highly recommended until platelet counts increase to acceptable levels. Platelet transfusions are reserved for severe thrombocytopenia or in cases of severe bleeding.

Idiopathic Thrombocytopenic Purpura Idiopathic thrombocytopenic purpura (ITP) is an



Figure 7-3 ► Ecchymosis. (Scott Camazine/Photo Researchers, Inc.)

autoimmune disorder resulting in excess destruction of platelets (Figure 7-4 ►). ITP most commonly occurs as an acute problem in children less than 5 years of age following a viral infection. It is characterized by the sudden appearance of petechiae. Most children recover in a few weeks. In adults, this disorder is chronic and rarely follows an acute viral infection.

The diagnosis of ITP is based on the appearance of severe thrombocytopenia. In patients with a suspected immune disorder, diagnosis is aided by analysis of the blood for the presence of antibodies or phagocytic cells.

The treatment of ITP depends on the age of the patient and the severity of the illness. Hemorrhage in patients with either acute or chronic ITP can usually be controlled by administration of corticosteroids. Removal of the spleen is reserved for patients who do not respond to medications or for those who are severely ill.

Coagulation Defects

Blood clotting or coagulation involves many different plasma proteins that form a blood clot, or a **thrombus**, that prevents blood loss from damaged tissues, blood vessels, or organs. Coagulation disorders can result from deficiencies or

impairment of one or more of the clotting factors. Deficiencies can arise because of defective synthesis, inherited disease, or increased breakdown of clotting factors.

Impaired Synthesis of Coagulation Factors Certain coagulation factors are synthesized in the liver. Coagulation factors VII, IX, X, and prothrombin require the presence of vitamin K for normal activity. In vitamin K deficiency, the liver produces an inactive form of the clotting factors. Vitamin K is a fat-soluble vitamin that is synthesized by intestinal bacteria; deficiencies occur when intestinal synthesis of vitamin K is interrupted or absorption of vitamin K is impaired. Vitamin K deficiency can occur in newborns because some have not yet developed the intestinal bacteria that synthesize the vitamin.

Hemophilia A

The most common inherited bleeding disorders are hemophilia A and von Willebrand's disease. According to the National Heart and Lung Institute, hemophilia A affects 1 in 5,000 male live births and von Willebrand's disease may affect more than 1 in every 1,000.

Hemophilia A is an X-linked recessive disorder that primarily affects males. It is caused by a deficiency in clotting factor VIII, and the severity of the disease depends on how the genetic defect affects the activity of the clotting factor. In mild to moderate forms of the disease, bleeding usually does not occur unless there is a local lesion or trauma such as surgery or dental procedures. Mild disorders may not be detected in childhood. In severe hemophilia, bleeding usually occurs in childhood and is spontaneous and severe, occurring up to several times per month.

Bleeding often occurs in the gastrointestinal tract and in the joints of the hip, knee, elbow, and ankle. The bleeding causes inflammation with acute pain and swelling. Without proper treatment, chronic bleeding and inflammation cause joint fibrosis that can progress to major disability. Intracranial hemorrhage is a cause of death in severe hemophilia.



Figure 7-4 ► Purpura, an inflammation of the blood vessels. (Centers for Disease Control and Prevention/Donated by Brian Hill, New Zealand)

Treatment of hemophilia A involves regular replacement of factor VIII, with additional doses administered during phases of acute bleeding. Patients with mild hemophilia A can sometimes be treated with a synthetic hormone called desmopressin, which stimulates the release of the carrier for factor VIII, thereby increasing blood concentration of factor VIII.

Von Willebrand's Disease

Von Willebrand's disease is an inherited bleeding disorder that is most often diagnosed in adulthood. It is caused by a deficiency in the von Willebrand clotting factor (vWF). Normal clotting requires platelets to stick to each other and to blood vessel walls. In the many forms of von Willebrand's disease, there is a defect in the adhesion of platelets. In addition, von Willebrand's disease is sometimes accompanied by reduced levels of factor VIII.

Usually a mild disease, symptoms of von Willebrand's disease include bruises from minor bumps, frequent nosebleeds, extended bleeding following dental procedures, heavy menstrual bleeds, and heavy bleeding following surgery. In severe cases, life-threatening gastrointestinal or joint hemorrhage may resemble symptoms of hemophilia.

Mild forms of von Willebrand's disease are often diagnosed following a severe bleeding episode. A variety of blood tests help diagnose the type and severity of the disease.

Treatment of von Willebrand's disease includes medications and lifestyle changes to minimize trauma. Medications are used to increase the release of vWF into the blood, replace vWF, prevent the breakdown of clots, and control heavy menstrual bleeding in women.

Disseminated Intravascular Coagulation

Disseminated intravascular coagulation (DIC) is a potentially life-threatening condition that involves destruction of the platelets and consumption of clotting factors. DIC occurs during sepsis or blood infection, endothelial damage as in states of shock, obstetrical complications associated with delivery of a child, and some types of cancer.

The pathogenesis of DIC involves the release of thrombin into the systemic circulation, causing

systemic coagulation and suppression of normal physiological anticoagulation mechanisms. Extensive clotting produces tissue ischemia, organ damage, and depletion of platelets and clotting factors. The depletion of platelets and clotting factors, also known as **consumptive coagulopathy**, results in extensive bleeding.

The diagnosis of DIC is based on the presence of clinical signs of bleeding in a patient with a clinical condition known to be associated with DIC. Clinically DIC is usually diagnosed on the basis of the underlying disease, observed low platelet counts on a peripheral blood test, increases in bleeding times, and the presence of degradation products in the blood plasma.

Treatment of the underlying disorder is required for DIC. Supportive medical treatments include platelet transfusions, administration of concentrates of coagulation inhibitors, and administration of an intravenous anticoagulant.

Disorders of White Blood Cells

Neutropenia

Neutropenia is a reduction of circulating neutrophils, which increases the risk for bacterial and fungal infections. Because neutrophils cause many of the signs of an acute infection, the classic signs such as swelling and pus formation may be diminished or absent in a severely neutropenic individual.

Neutropenia is a frequent complication of cancer chemotherapy or medical immune suppression because these medications suppress cellular proliferation within the bone marrow. Infectious complications depend on the severity of neutropenia and are usually profound and severe in cancer patients.

Immune destruction of neutrophils occurs with rheumatoid arthritis or as a primary condition with unknown causes. Neutropenia may be either mild or severe, and infectious complications are variable. Chronic and severe cases require medical treatment with medications that increase neutrophil proliferation or medications that suppress immune function.

Patients with chronic neutropenia may experience chronic infections. Acute and severe neutropenia may be associated with fever, skin

inflammation, liver abscesses, and septicemia, or infection in the blood.

Diagnosis of neutropenia is based on a complete blood count. Examination of the bone marrow is useful to diagnose bone marrow failure syndromes that may be causing the neutropenia.

The treatment of neutropenia depends on its cause and severity. Sometimes neutropenia may resolve without treatment. Those with mild neutropenia generally have no symptoms and may not need treatment. People with severe neutropenia are at risk for high fevers and severe infections. Hospitalization with isolation and intravenous antibiotic therapy is needed for the severely neutropenic patient.

Growth factors, called colony-stimulating factors, which stimulate the production of white blood cells, are especially helpful for patients who develop neutropenia secondary to cancer treatment. Corticosteroids may help if the neutropenia is caused by an autoimmune reaction.

Eosinophil Abnormalities

Idiopathic Hypereosinophilic Syndrome Hyper-eosinophilia describes a high level of eosinophils. Hypereosinophilia can occur in response to a parasitic infection and is a normal immune response. In these cases, eosinophils return to a normal level after the infection clears.

Idiopathic hypereosinophilic syndrome occurs mainly in males between the ages of 20 and 50 years. Persistent increases in blood eosinophils and associated involvement of the heart and nervous system are responsible for the most important clinical symptoms. Heart problems include congestive heart failure, valve dysfunction, conduction defects, and myocarditis. Congestive heart failure is a frequent cause of death. Neurologic problems include altered behavior and cognitive function, spasticity, and ataxia.

Prognosis for idiopathic hypereosinophilic syndrome is poor without treatment, with median survival of approximately 1 year. However, chemotherapy has recently been reported to produce 70% survival at 10 years.

Eosinophilia-Myalgia Syndrome A chronic, multisystem disease, **eosinophilia-myalgia syndrome**, is characterized by muscle pain, fatigue, and a progressive, potentially fatal illness characterized by skin changes, nervous system abnormalities, and pulmonary hypertension. Elevated circulating levels of eosinophils are a universal feature of this disorder. The illness has been related to ingestion of the dietary supplement L-tryptophan.

Age-Related Diseases

Anemia is the most common blood disorder in persons greater than 75 years of age. The causes of anemia in older adults are blood loss and nutritional deficiencies, chronic illness, and chronic renal failure. Decreased physical performance, mental status changes, and an increase in mortality are among the consequences of untreated anemia in older adults. White blood cell disorders, platelet disorders, and immune deficiency are often due to malignant disease. Neutropenia, thrombocytopenia, and nutritional anemias develop secondary to the malignancy and cancer treatments.

Resources

Centers for Disease Control: www.cdc.gov/ncbddd/hbd/default.htm
 National Heart, Lung, and Blood Institute: www.nhlbi.nih.gov/health/dci/Diseases/vwd/vwd_what.html
 National Institutes of Medicine: www.nlm.nih.gov/medlineplus/bloodandblooddisorders.html
 World Health Organization: www.who.int/nutrition/publications/anaemia_iron_pub/en

Diseases at a Glance

Blood

Disease	Etiology	Signs and Symptoms
Iron-deficiency anemia	Iron loss	Fatigue, decreased exercise tolerance, shortness of breath
Anemia of chronic disease and renal disease	Defect in erythropoiesis	Fatigue, decreased exercise tolerance, shortness of breath
Vitamin B ₁₂ -deficiency anemia	Impaired intake or absorption of vitamin B ₁₂	Abdominal distress, nausea, vomiting, and burning of the tongue
Folic acid-deficiency anemia	Impaired intake, depletion of body stores	Fatigue, decreased exercise tolerance, shortness of breath
Sickle cell anemia	Genetics: results in formation of abnormal hemoglobin	Pallor, fatigue, shortness of breath, painful sickle cell crisis
Thalassemia	Genetics: results in formation of defective hemoglobin	Pallor, fatigue, shortness of breath
Polycythemia vera	Idiopathic, unknown	Dizziness, headaches, and visual disturbances
Idiopathic thrombocytopenic purpura	Viral infection in children; unknown in adults	Bleeding
Hemophilia A	Genetic: results in deficiency of clotting factor VIII	Bleeding
Von Willebrand's disease	Genetic: results in decreased platelet adhesion	Bleeding
Disseminated intravascular coagulation	Sepsis, endothelial damage, shock	Bleeding
Neutropenia	Medications, cancer, chemotherapy, immune disorders	Infection, fever, skin inflammation, and fever
Idiopathic hypereosinophilic syndrome	Unknown	Cardiac symptoms can lead to congestive heart failure
Eosiniphilia myalgia syndrome	Ingestion of dietary supplements containing L-tryptophan	Skin changes, nervous system abnormalities, pulmonary hypertension

Diagnosis	Treatment	Prevention
Blood test	Iron replacement	Iron-fortified diet, iron replacement in high-risk individuals
Blood test, evidence for primary disease	Erythropoietin and iron	Treatment of the underlying disease
Blood test, health history	Replacement of vitamin B ₁₂	Treatment of underlying condition impairing vitamin B ₁₂ absorption
Blood test	Replacement of folic acid	Folic acid–fortified diet
Genetic testing, blood test	Prevention of sickle cell crisis; supportive therapy and analgesics; blood transfusion	Cannot prevent sickle cell disease
Genetic testing, blood test	Supportive care; blood transfusion	Cannot prevent thalassemia
Blood test	Chemotherapy, blood letting	Unknown
Blood test	Corticosteroids, splenectomy	Unknown
Genetic test, blood test	Replacement of factor VIII	Cannot prevent hemophilia
Genetic test, blood test	Desmopressin	Cannot prevent von Willebrand's disease
Blood test; clinical signs and symptoms in high-risk patients	Supportive; platelet transfusions	Cannot prevent this condition; difficult to predict when it will occur
Blood test	Medications to increase neutrophil count; antibiotics	Cannot prevent neutropenia
Blood test	Chemotherapy	Unknown
Blood test	Discontinue use of the causative agent	Unknown as contaminants can be present without notice

Interactive Exercises

Cases for Critical Thinking

1. A 42-year-old female has been fatigued for the past few months. The onset of her illness was poorly defined, and aside from a lack of energy she has no other complaints. She reported becoming short of breath when climbing the stairs or walking for a prolonged distance. She told her doctor that she had recently experienced some weight loss following the death of her mother. What diseases or conditions should be considered in this patient? What additional information do you need to make a correct diagnosis?
2. B.K. is a 65-year-old male admitted to the hospital for surgery. B.K. had been on blood thinners in the past for the treatment of a clotting disorder. He is fearful of going to the hospital because last time he had a severe bleeding episode. What conditions should B.K.'s doctors be concerned about? What are some of the symptoms and diagnostic tests that should be considered for this patient?

Multiple Choice

1. The oxygen-carrying component of red blood cells is _____.
 - a. vitamin B₁₂
 - b. folic acid
 - c. erythropoietin
 - d. hemoglobin
2. In anemia of chronic disease and anemia of chronic renal failure, the defect in the synthesis of red blood cells is due to a lack of _____.
 - a. erythropoiesis
 - b. iron
 - c. hemoglobin
 - d. folic acid
3. Pernicious anemia is due to inadequate absorption of _____.
 - a. vitamin B₁₂
 - b. folic acid
 - c. erythropoietin
 - d. hemoglobin
4. The kidneys produce _____, which stimulates erythrocyte production.
 - a. vitamin B₁₂
 - b. folic acid
 - c. erythropoietin
 - d. hemoglobin
5. Disorders affecting the structure and function or production of hemoglobin are classified as _____.
 - a. hemolytic anemia
 - b. iron-deficiency anemia
 - c. hemoglobinopathy
 - d. folic acid-deficiency anemia
6. Deficient synthesis of one or more of the alpha or beta chains of the hemoglobin molecule is characteristic of _____.
 - a. hemolytic anemia
 - b. thalassemia
 - c. sickle cell anemia
 - d. iron-deficiency anemia
7. A disease of increased viscosity of the blood with associated neurological symptoms is known as _____.
 - a. polycythemia vera
 - b. disseminated intravascular coagulation
 - c. sickle cell anemia
 - d. thalassemia
8. _____ is an autoimmune disorder resulting in destruction of platelets.
 - a. Disseminated intravascular coagulation
 - b. Polycythemia vera
 - c. Hemophilia A
 - d. Idiopathic thrombocytopenic purpura

9. _____ is an X-linked recessive disorder that primarily affects males and results in a deficiency of clotting factor VIII.
- Disseminated intravascular coagulation
 - Polycythemia vera
 - Hemophilia A
 - Idiopathic thrombocytopenic purpura
10. _____ is a reduction in circulating white blood cells that increases the risk for severe bacterial and fungal infections.
- Hemophilia
 - Neutropenia
 - Thrombocytopenia
 - Coagulopathy

True or False

- _____ 1. Chemotherapy can be used to treat idiopathic hypereosinophilic syndrome.
- _____ 2. Hemoglobin is the most important component of white blood cells.
- _____ 3. The production of red blood cells is regulated by a kidney hormone, called erythropoietin.
- _____ 4. The symptoms of neutropenia are due to hypoxia.
- _____ 5. The diagnosis of anemia requires hematocrit and microscopic examination of blood in a peripheral blood smear.
- _____ 6. Vitamin K is required for the synthesis of clotting factors.
- _____ 7. Von Willebrand's disease is a hereditary deficiency of vitamin K.
- _____ 8. The depletion of platelets in disseminated intravascular coagulation is also known as a consumptive coagulopathy.
- _____ 9. Enlargement of the spleen occurs in anemia caused by hemolysis.
- _____ 10. Iron supplementation can be used to treat the most common form of anemia.

Fill-Ins

- White blood cells are called _____.
- Mature red blood cells are called _____.
- Sickle cell disease causes formation of _____ that forms cross-links and sickling of red blood cells.
- Thrombocytopenia is a disease in the circulating levels of _____.
- Two common and severe forms of thalassemia are _____ and _____.
- The leading cause of anemia worldwide is _____.
- Vitamin B₁₂ and folic acid deficiency both cause _____.
- Red blood cells normally survive in the circulation for about _____ days.
- A rise in red blood cell mass accompanied by an increase in white blood cells and platelets is known as _____.
- The pathogenesis of disseminated intravascular coagulation involves the release of _____ into the circulation, causing extensive coagulation followed by consumption of platelets and clotting factors.

Chapter 8

Diseases and Disorders of the Respiratory System

Learning Objectives

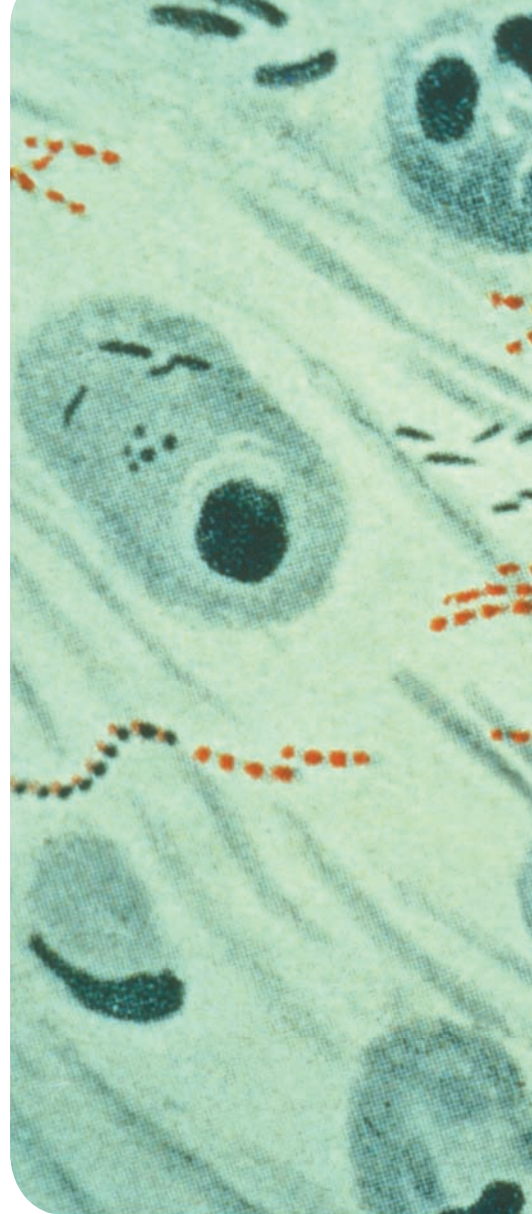
After studying this chapter, you should be able to

- Describe the normal structure and function of the respiratory system
- Identify common signs and symptoms associated with respiratory diseases
- Describe diagnostic testing used in respiratory diseases
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for upper respiratory diseases
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for lower respiratory diseases
- Describe the effects of aging on the respiratory system

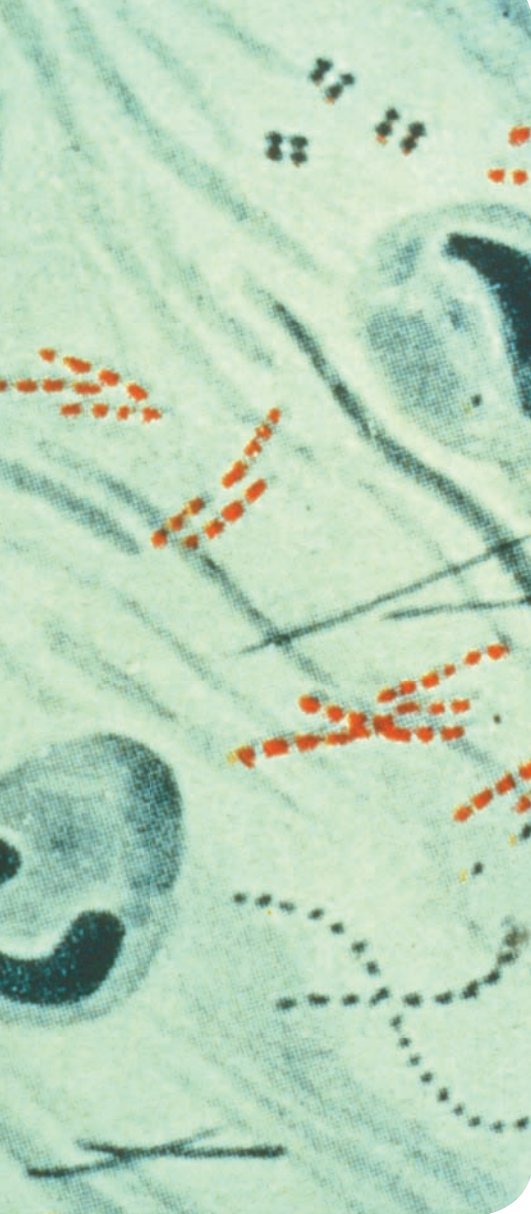
Fact or Fiction?

In humans the right lung is slightly larger than the left lung.

True: The right lung's larger size is due to the heart being located on the left side of the body.



Mycobacterium tuberculosis bacteria from a sputum specimen, viewed with Ziehl-Neelsen stain. (Courtesy of the Centers for Disease Control and Prevention, 1979)



Disease Chronicle

Tuberculosis Past and Present

Tuberculosis (TB) is an ancient bacterial respiratory disease known from the days of the Egyptian pharaohs. The rate of its spread was once restricted by ancient modes of relatively slow travel. With the advent of antibiotics doctors thought TB could be beat. However, today TB still kills an estimated 3 million persons per year throughout the world. This respiratory killer is considered a reemerging disease because its prevalence is on the rise as a result of HIV/AIDS, rapid world travel, and the evolution of drug-resistant strains. Worse yet, doctors have noted the emergence of multi-drug-resistant TB, extensively resistant TB, and a few cases of completely drug-resistant TB. These strains of tuberculosis return the world to the days of the pharaohs, when there were no effective treatments for this deadly disease.

Anatomy and Physiology Review

Our body cells require a continuous supply of oxygen to perform vital functions including growth, reproduction, and maintenance. As our body cells use oxygen, they give off carbon dioxide, a waste product the body must dispose of. The respiratory and cardiovascular systems share responsibility for supplying the body with oxygen and disposing of carbon dioxide. The respiratory system oxygenates the blood and removes carbon dioxide. The cardiovascular system transports these gases in the bloodstream. The respiratory system includes the chest (thorax), lungs, and conducting airways.

The entire lining of the respiratory tract, and its **respiratory epithelium**, is coated with a mucus film. In addition, numerous hairlike projections called **cilia** project from the surface of the

pharynx and trachea. The cilia exert a sweeping action, preventing dust and foreign particles from reaching the lungs. The mucous membrane also protects the lungs by moistening and warming inhaled air starting in the nasal cavity.

Air enters the nasal and oral cavities, passes back through the **pharynx**, and down through the **larynx** to the **trachea**. The trachea descends and branches into two primary **bronchi**, one for each lung. The trachea and bronchi are kept open by sturdy rings of tracheal cartilage. The bronchi branch into smaller and smaller tubules called **bronchioles**, which lack cartilaginous rings. The branching tubules resemble an inverted tree and are often referred to as the bronchial tree. The bronchioles terminate in the lungs as small air sacs called **alveoli**. Figure 8-1 ► illustrates the respiratory system.

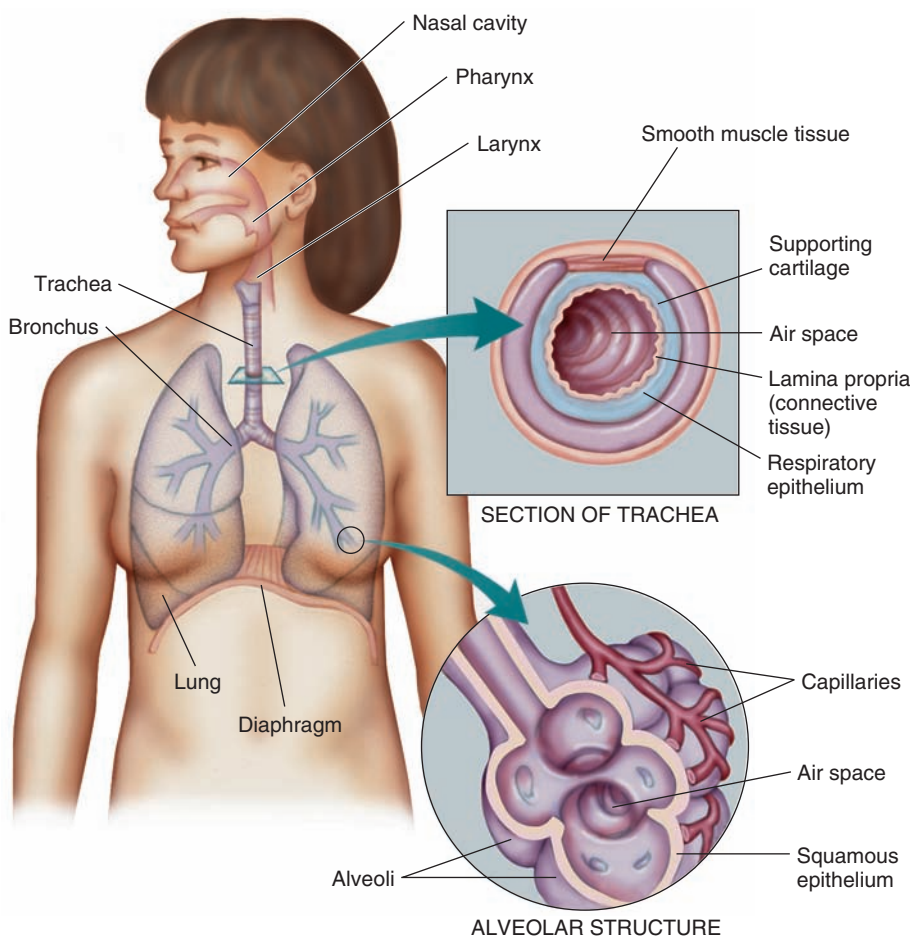


Figure 8-1 ► The respiratory system.

The lungs are encased by a double membrane consisting of two layers called **pleura**. One layer of this thin membrane covers the lung surface, and the other lines the thoracic cavity. Between these pleura is the **pleural cavity**, which contains a small amount of pleural fluid. This fluid lubricates the lung and thoracic surfaces, reducing friction as the lungs expand and contract. The fluid also reduces surface tension, which helps keep the lungs flexible. The airtight space between the lungs and the chest wall has a pressure slightly less than the pressure within the lungs. This difference is called **intrapleural pressure**, which acts as a partial vacuum and prevents the lung from collapsing.

The alveoli are thin-walled sacs surrounded by blood capillaries and are the site of gas exchange. Inspired or inhaled oxygen diffuses across the pulmonary membrane from the alveoli into the capillary blood. The hemoglobin molecules within the red blood cells bind oxygen for transport to the tissues. Carbon dioxide that is given off into the blood as a waste from the cells diffuses primarily from the blood plasma into the alveoli to be expired, or exhaled. See Figure 8-2 ▶.

To deliver oxygen to the alveoli, air must be inspired into the lungs. The **diaphragm** and the muscles between the ribs, called external intercostals, are the main muscles of inhalation. Contraction of these muscles increases

the volume or space within the chest cavity, which decreases the pressure within the lungs and draws air into the lungs. As these muscles relax, the volume of the chest cavity decreases, which increases pressure and pushes air out of the lungs. Other muscles that assist exhalation include abdominal and internal intercostal muscles, which are utilized during times of exertion. The activity of the diaphragm and external intercostals is regulated by the medulla and pons in the brain. Physical factors (talking, coughing, exercising), emotional factors (fear, sadness), and chemical factors (levels of carbon dioxide and oxygen) can affect the depth and rate of breathing. We also have voluntary control of our breathing; however, it is limited as the brain will override volition when necessary.

Three key disruptions of respiratory function can lead to disease: interference of air flow, interference with diffusion of gases at the respiratory membrane, and blocked or reduced blood flow through alveolar capillaries.

Respiratory diseases share many signs and symptoms. See Table 8-1 ▶.

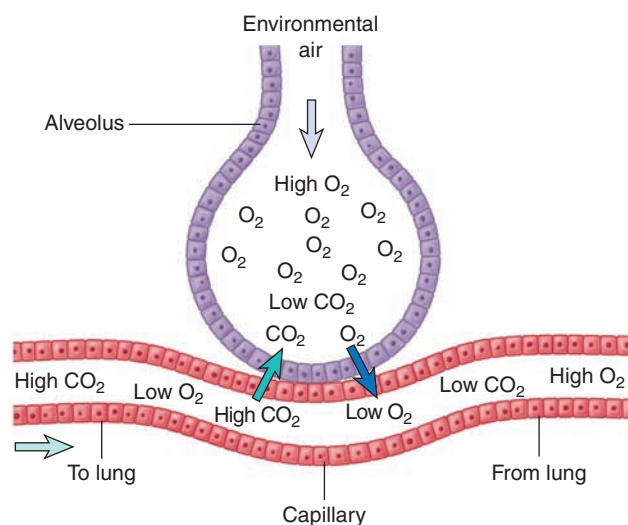


Figure 8-2 ▶ Exchange of gases between lungs and blood. High concentration of CO_2 in blood capillary entering the lung diffuses into alveolus. High concentration of O_2 in alveolus diffuses into blood capillary leaving lung.

TABLE 8-1 Common Signs and Symptoms of Respiratory Diseases

Chest pain
Dyspnea or difficulty breathing
Wheezing
Cough—productive or nonproductive, acute or chronic
Hemoptysis or coughing blood
Fatigue
Fever—low or high grade
Dysphonia or hoarseness
Cyanosis—a blue color in skin and nails; indicator of low oxygen
Sinus and nasal drainage
Clubbing of fingers or toes, indicator of low oxygen or circulatory problems
Tachypnea or rapid breathing
Abnormal breath sounds

Diagnostic Tests and Procedures

Physical examination of the respiratory system begins with auscultation, or listening to the chest with a stethoscope. Bronchial sounds are produced by air rushing through the trachea and bronchi and sound like air being blown through a hollow tube. Vesicular breathing sounds occur as air fills the alveoli, producing a quiet, rustling sound. Respiratory disease can produce abnormal breath sounds. See Table 8-2 ►.

With percussion, or tapping on the chest, the note raised and the vibration felt give clues to the state of the underlying lung and pleura. By percussion it is possible to assess the relative proportion of air, solid tissue, or fluid underlying the area. See Table 8-3 ►.

Pulmonary function tests are used to measure air flow within the lungs and evaluate lung function. **Spirometry** is the first and most commonly done lung function test. Spirometry measures the air capacity of the lungs. In this test, the patient inhales as deeply as possible, places a tube into the mouth that is attached to an apparatus called a spirometer, and exhales as quickly and with as much force as possible (Figure 8-3 ►). In most

cases, this test is repeated three times to get an accurate measurement. Spirometry measures a number of different values; if these rates are lower than expected for the patient’s age, sex, height, and weight, decreased lung function is indicated.

Peak flow, also called peak expiratory flow rate, is measured with a device that consists of a tube and a gauge to measure the maximum force with which a patient can exhale (Figure 8-4 ►). Normal peak flow rates vary from person to person, and low rates can indicate decreased lung function. For home use, a peak expiratory flow meter can be used to monitor a patient’s condition. These small, handheld devices can quantify asthma severity to assist in treatment and control. Each patient needs to establish a baseline to compare to norms for their age and gender.

The bronchial challenge test is used to detect and quantify airway hypersensitivity. A non-specific agent such as methacholine is used to demonstrate airway hypersensitivity. Patients perform spirometry without inhaling methacholine and then inhale increasingly higher doses of methacholine. If the patient develops dyspnea, tightness in the chest, coughing, wheezing, or

TABLE 8-2 Abnormal Breath Sounds		
Abnormal breath sound	Description	Cause
Wheezing	High-pitched, continuous, whistling sound.	Airway secretions and narrowing of airway.
Crackles	Fine crackles are brief, discontinuous, popping lung sounds that are high-pitched. Fine crackles are also similar to the sound of wood burning in a fireplace, or hook-and-loop fasteners being pulled apart, or cellophane being crumpled. Higher-pitched and have a shorter duration than coarse crackles. Coarse crackles are discontinuous, brief, popping lung sounds. Compared to fine crackles they are louder, lower in pitch, and last longer. They have also been described as a bubbling sound. You can simulate this sound by rolling strands of hair between your fingers near your ear.	Airway secretions and airway opening. Inhaled air collides with previously deflated airways and the airways suddenly pop open, creating a crackling sound as gas pressure between the two compartments equalizes.
Pleural rub	Creaking sound similar to walking on fresh snow.	Decreased lubrication causes the two pleura to rub against each other.

TABLE 8–3 Percussion Sounds in the Chest

Sound	Description
Resonance	Low-pitched sound heard over normal lungs
Hyperresonance	Loud, low-pitched sound than normal resonance heard over hyperinflated lungs
Tympany	Drum-like, loud, empty quality. Not a normal chest sound. Indicate excessive air in the chest.
Dull	Normally heard over dense areas such as the heart or liver. Dullness replaces resonance when fluid or solid tissue replaces air-containing lung tissues.

airflow obstruction, the patient's airways are hypersensitive.

Pulse oximetry is a procedure used to measure the oxygen level (or oxygen saturation) in the blood. It is a noninvasive, painless, general indicator of oxygen delivery to the peripheral tissues. In oximetry, an electronic device called a pulse oximeter is attached to a part of the body (e.g., fingertip, earlobe, forehead). Oxygenated blood is brighter red than oxygen-deprived blood, which is bluish-purple in color. The pulse oximeter transmits beams of light through blood vessels (capillaries), measures

differences in color, and calculates blood oxygen levels. The blood oxygen level then is displayed on an electronic screen as the oxygen saturation rate. Normal rates are greater than 90%. Lower rates indicate a decrease in lung function.

Arterial blood gases (ABGs) are used to evaluate levels of oxygen and carbon dioxide and blood pH, key indicators of respiratory function. This procedure requires an arterial puncture to draw blood samples. Normal arterial blood gases should be high in oxygen and low in carbon dioxide.



Figure 8–3 ▶ Spirometer. (Photographer: Digital Vision. © 2013 Thinkstock. All rights reserved.)



Figure 8–4 ▶ Peak flow meter. (Photographer: Stockbyte. © 2013 Thinkstock. All rights reserved.)

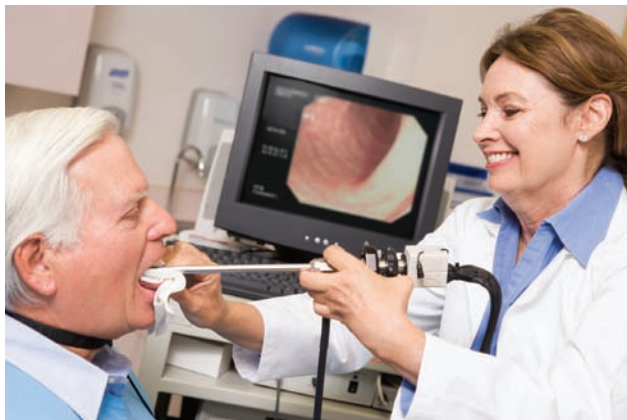


Figure 8-5 ► Bronchoscopy. (© 2013 Thinkstock. All rights reserved.)

Sputum analysis (staining, culture, and cytology) is helpful in the diagnosis of some respiratory diseases. Biopsy and imaging tests including bronchoscopy (visual examination of air passages leading to the lungs) (Figure 8-5 ►), laryngoscopy (visual examination of the back of the throat), chest x-rays (Figure 8-6 ►), and CT and MRI scans help confirm the diagnosis of respiratory diseases.



Figure 8-6 ► Chest x-ray. (© 2013 Thinkstock. All rights reserved. Photo credit: Medioimages/Photodisc.)

Upper Respiratory Diseases

The Common Cold

The common cold is an acute contagious disease of the upper respiratory tract that is marked by inflammation of the mucous membranes of the nose, throat, eyes, and eustachian tubes with a watery, then purulent, discharge. The average incidence of the common cold is five to seven colds per year in preschool children and two to three colds per year in adulthood. The risk factors for cold include age (infants and preschoolers), exposure to infected people, being immunocompromised, and time of year (fall and winter).

Signs and symptoms may include sore throat, runny nose, sneezing, and cough. Colds are caused by more than 200 different viruses, the rhinoviruses being the most common cause followed by the coronavirus. The virus is transmitted by respiratory droplets (cough, sneeze) or by touching an inanimate object contaminated with the virus and then touching your eyes or nose. Diagnosis is based on physical examination and signs and symptoms.

There is no cure for the common cold, but symptomatic treatment including pain relievers, decongestants, antihistamines, and cough suppressants may be helpful. To help prevent the common cold, avoid close contact with anyone who has a cold, wash your hands frequently, and practicing proper respiratory hygiene. (See the Prevention Plus! on respiratory hygiene.)

Allergic Rhinitis

Allergic rhinitis is an inflammation of the mucous membrane of the nose caused by allergic reaction to airborne substances. Approximately 17 million, or 7%, of American adults are diagnosed with allergic rhinitis in any 12-month period. Risk factors include family history, having other allergies, and exposure to allergens.

Signs and symptoms may include runny nose, congestion, watery eyes, and sneezing. Allergic rhinitis signs and symptoms are caused by hypersensitivity to an allergen. Immunoglobulin E binds to mast cells and induces them to release histamine and other potent chemicals responsible for allergic rhinitis signs and symptoms. Diagnosis depends on physical examination, medical history, and allergy testing.

Prevention PLUS!

Respiratory Hygiene



(CDC/Brian Judd/Photo credit: James Gathany)

Coughs and sneezes produce tremendous numbers of respiratory droplets that can carry infectious bacteria and viruses. Practice respiratory hygiene to protect yourself and others from these infections.

- Cover your mouth and nose with a tissue when you cough or sneeze or cough and sneeze into the corner of your elbow, not into your hands
- Discard used tissues in trashcans
- Wash your hands with soap and warm water for 20 seconds after coughing, sneezing, or blowing your nose

Treatment may include avoiding the allergen, if possible, and nasal steroids. Some people undergo treatment to desensitize them to allergens (allergy shots). Desensitizing works by administering gradually increasing doses of allergen, which stimulate the production of antibodies to neutralize the allergens, preventing them from triggering the allergic response. Allergic rhinitis can be avoided by avoiding exposure to the allergens, but otherwise it is not preventable.

Sinusitis

Sinusitis is inflammation of the mucous membrane lining of the sinuses. The sinuses are air-filled cavities behind the facial bones. Approximately 30 million Americans are diagnosed with sinusitis each year. Risk factors for sinusitis include having an upper respiratory infection, allergies, obstruction of the nose (deviated septum, polyps), and a weakened immune system.

A common cold often leads to sinusitis because the mucous membranes that line the nasal cavity extend into and also line the sinuses (Figure 8-7 ►). Sinusitis signs and symptoms may include facial pain and pressure, nasal stuffiness, nasal discharge, loss of smell, and cough or congestion. Sinusitis is usually caused by a viral infection, often the common cold virus.

Diagnosis may include medical history, physical examination, nasal endoscopy to visually inspect the sinuses, imaging tests, nasal and sinus cultures, and allergy testing.

Treatment is symptomatic and may include using a saline nasal spray to rinse the nasal passages, nasal corticosteroids to reduce inflammation, decongestants, and pain relievers. Preventing sinusitis includes avoiding upper respiratory infections, managing allergies, avoiding smoke and pollutants, and using a humidifier.

Tonsillitis

The tonsils are fleshy pieces of lymphatic tissue that rest in the back of the throat above and below the tongue. As part of the immune system, the tonsils help fight infections. However, if bacteria or viruses contaminate the tonsils, the result is an infectious inflammation of the tonsils, or tonsillitis (Figure 8-8 ►). The prevalence of tonsillitis is not known. Risk factors for tonsillitis include young age and frequent exposure to people with bacterial or viral infections.

Signs and symptoms may include a severe sore throat; red, swollen tonsils; difficulty or painful swallowing; white or yellow patches on the tonsils; and fever. Bacterial and viral infections are the cause of tonsillitis. Diagnosis is based on

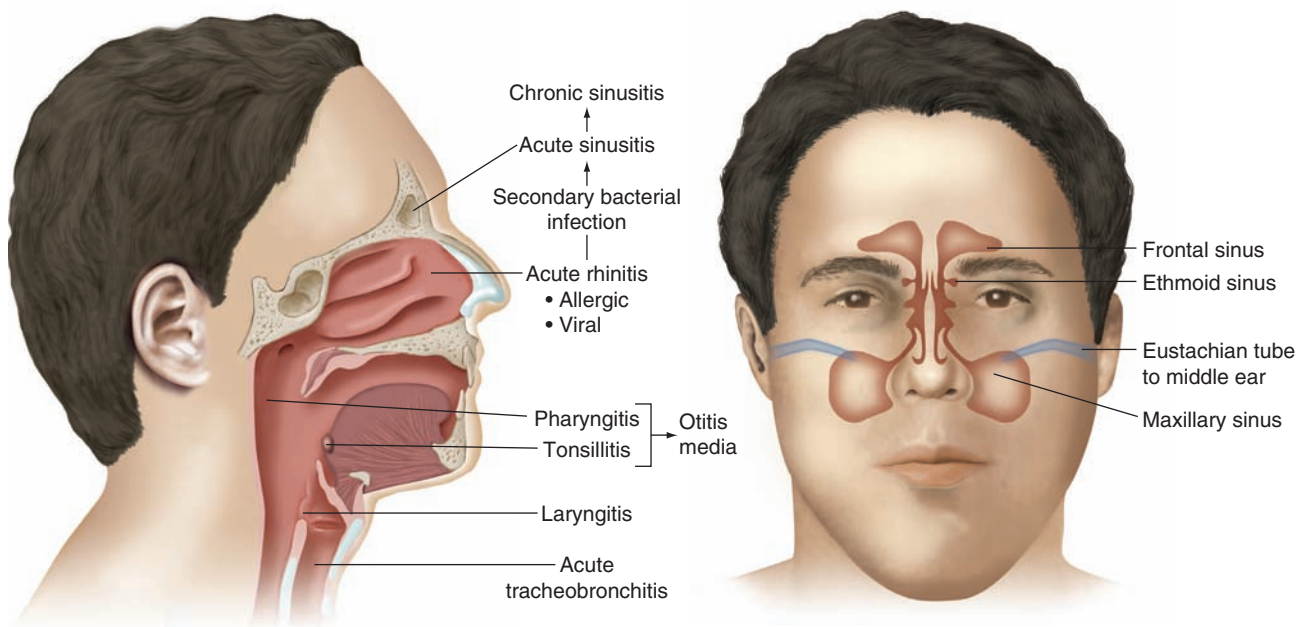


Figure 8-7 ▶ Paranasal sinuses are part of the upper respiratory system. From here, infections may spread via the nasopharynx to the middle ear or inferiorly to the bronchi.

visual examination of the tonsils; a rapid strep test or throat culture may also be done.

Treatment depends on the cause of the tonsillitis. If it is a result of a bacterial infection antibiotics are an appropriate treatment. Treatment for viral tonsillitis is symptomatic and may include pain relievers, rest, and fluids. If infections are severe and recurrent, the tonsils

may be surgically removed. Tonsillitis can be prevented by avoiding close contact with people with a respiratory infection, practicing proper respiratory hygiene, and frequent handwashing.

Pharyngitis

Pharyngitis, an inflammation of the pharynx, is characterized by pain in the throat. Approximately 30 million cases of pharyngitis are diagnosed annually in the United States. Risk factors include living or working in close quarters, being immunocompromised, having diabetes mellitus, and smoking or exposure to cigarette smoke. The main symptom is a sore throat. Other signs and symptoms may include fever, headache, swollen lymph nodes in the neck, and joint pain or muscle aches.

The most common cause of pharyngitis is a viral infection; bacterial infections can also cause pharyngitis. Diagnosis is based on physical examination and may include a rapid strep test or throat culture.

Treatment depends on the etiological agent. Treatment for viral pharyngitis is symptomatic and may include gargling with salt water, anti-inflammatory medications, and pain relievers. Antibiotics are appropriate for treating bacterial

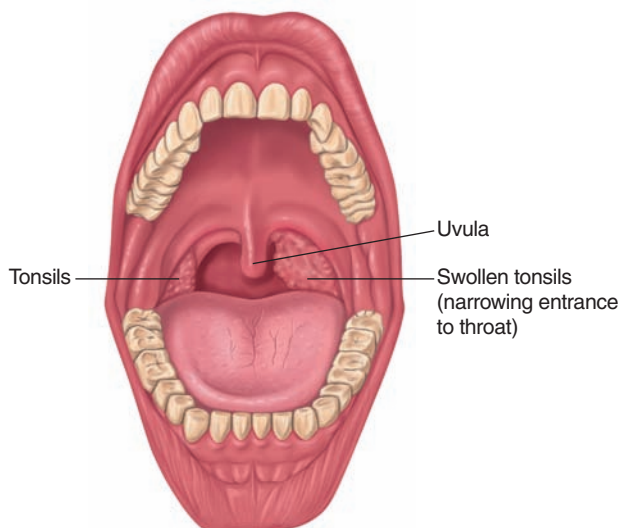


Figure 8-8 ▶ Normal and enlarged tonsils.

pharyngitis. Prevention includes practicing proper respiratory hygiene, frequent handwashing, and avoiding close contact with anyone with a respiratory infection.

Laryngitis

Laryngitis is inflammation of the larynx or voice box. The prevalence of laryngitis is not known. Risk factors include having a respiratory infection, exposure to irritating substances (cigarette smoke, alcohol, stomach acid, workplace chemicals), and overuse of the voice. Dysphonia is the main sign of laryngitis. Other signs and symptoms may include difficulty swallowing, throat pain, and fever.

The most common cause of laryngitis is a viral infection; other causes include overuse of the voice or bacterial infections. Diagnosis is based on signs and symptoms and physical examination and may include laryngoscopy to visually examine the vocal cords.

Treatment is focused on treating the underlying cause and may include resting the voice, controlling heartburn, and reducing exposure to alcohol or cigarette smoke. Corticosteroids may be used to reduce inflammation of the vocal cords. Prevention includes frequent handwashing, avoiding people with respiratory infections, practicing proper respiratory hygiene, not smoking, and limiting exposure to secondhand smoke.

Lower Respiratory Diseases

Influenza

Influenza is an acute, highly contagious respiratory infection. According to the Centers for Disease Control and Prevention, 5–10% of the U.S. population is infected with the flu each year, 200,000 are hospitalized, and 36,000 die from flu complications. The World Health Organization estimates 3–5 million people worldwide are infected with the flu each year, resulting in 250,000–500,000 deaths. Those at high risk for developing flu-related complications include children under age 5, adults over age 65, pregnant women, and people with immune deficiency, HIV/AIDS, cancer, diabetes mellitus, and chronic respiratory diseases such as asthma, bronchitis, cystic fibrosis, emphysema, or other chronic disease.

The signs and symptoms of flu come on suddenly and may include fever, cough, muscle or body aches, headache, fatigue, and chest discomfort. Complications of flu can include bacterial pneumonia, ear infections, sinus infections, dehydration, and worsening of chronic medical conditions. The virus is transmitted by respiratory droplets (cough, sneeze) or by touching an inanimate object contaminated with the virus and then touching your eyes or nose.

The flu is caused by infection with the influenza virus. The flu is more common in the winter months, and outbreaks of the illness occur nearly every year throughout the world. The extent and severity of influenza outbreaks vary considerably from year to year and from location to location. Serious local outbreaks generally occur about every 1–3 years, and global outbreaks (pandemics) occur about every 10–15 years.

Diagnosis is usually based on signs and symptoms; there are diagnostic tests available that can detect the flu virus. The flu usually resolves within 2 weeks without medical intervention. Antiviral medications may be used to shorten the severity and duration of the flu and reduce the risk of complications. Other treatment is symptomatic and may include a cough suppressant and acetaminophen to relieve headaches and muscle or body aches and reduce fever.

To help prevent the flu, avoid close contact with people who have the flu. Wash your hands frequently and avoid touching your eyes, nose, and mouth. Practice proper respiratory hygiene. The best way to prevent the flu is to receive a flu vaccine each year. The signs and symptoms of allergy, influenza, and cold overlap but remain distinctive (Table 8–4 ►).

Pneumonia

Pneumonia is an infection in one or both lungs affecting primarily the alveoli. The alveoli are filled with pus and fluid, which makes breathing painful and limits oxygen intake. Approximately 3 million cases of pneumonia are diagnosed and 60,000 people die of pneumonia each year in the United States. The risk factors for pneumonia include age (younger than 5 years or over 65 years), immune deficiency, having certain chronic diseases (asthma, heart disease, chronic obstructive pulmonary disease), smoking, and

TABLE 8–4 Comparing Signs and Symptoms of Cold, Allergy, and the Flu

Sign or symptom	Allergy	Cold	Flu
Onset	Fast response to allergen	Slow	Fast
Duration	Less than 1 week	1 week	1–3 weeks
Season	Spring through late summer	Fall and winter	Fall and winter
Fever	Never	Rare, less than 100°F	Usual, often 102–104°F or higher; lasts 3–4 days
Headache	Usual	Rare	Prominent
General aches, pains	Never	Slight	Usual; often severe
Stuffy, runny nose	Common	Common	Sometimes
Sneezing	Usual	Usual	Sometimes
Sore throat	Sometimes	Common	Sometimes
Cough	Sometimes	Common, hacking	Common, can become severe
Chest discomfort	Rare	Mild to moderate	Common
Fatigue, weakness	Sometimes	Sometimes	Usually, can last a couple of weeks after recovery
Extreme exhaustion	Never	Never	Usual, at the beginning of the illness

being on a mechanical ventilator. When someone develops pneumonia in the community (not in a hospital), it is called community-acquired pneumonia. Pneumonia developed during or following a stay in a health care facility (e.g., hospitals, long-term care facilities, and dialysis centers) is called health-care-associated pneumonia, which includes hospital-acquired pneumonia and ventilator-associated pneumonia.

Signs and symptoms of pneumonia include cough (the person may cough up mucus or blood), fever, chills, dyspnea, and chest pain. Auscultation may reveal reduced breath sounds and crackles. The percussion note is dull.

Pneumonia is usually caused by a bacterial or viral infection. In the United States, the most common cause of bacterial pneumonia is *Streptococcus pneumoniae* and the most common causes of viral pneumonia are the influenza, parainfluenza, and respiratory syncytial viruses. Other common bacterial and viral causes of pneumonia in the United

States include *Staphylococcus aureus* and adenovirus. The fungus *Pneumocystis jirovecii* is a common cause of pneumonia in patients with AIDS.

Diagnosis is based on medical history, physical examination, a chest x-ray (Figure 8–9 ►), and sputum culture. Treatment varies with the etiological agent. Bacterial pneumonia is treated with antibiotics. Viral pneumonia treatment is symptomatic and may include rest, oxygen therapy, increased fluid intake, pain relievers, and a high-calorie diet.

Prevention includes vaccination (seasonal flu shot, pneumococcal), frequent handwashing, practicing proper respiratory hygiene, and not smoking.

Tuberculosis

Tuberculosis (TB) is a potentially fatal contagious disease that can affect almost any part of the body but is mainly an infection of the lungs.

Prevention PLUS!

Appropriate Antibiotic Use

Antibiotics are used to treat bacterial infections. They are not effective against viral infections. Half of all antibiotic prescriptions may be inappropriate; four out of five Americans are prescribed antibiotics each year.

Think Critically

1. Are antibiotics an appropriate treatment for a viral infection?
2. Should you take an antibiotic to treat a common cold?
3. Should you take an antibiotic to treat the flu?



Get Smart. Take a look at this chart to find out which upper respiratory infections are usually caused by viruses — germs that are not killed by antibiotics. Talk with your doctor about ways to feel better when you are sick. Ask what you should look for at home that might mean you are developing another infection for which antibiotics might be appropriate.

Illness	Usual Cause		Antibiotic Needed
	Virus	Bacteria	
Cold	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Flu	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Chest Cold (in otherwise healthy children and adults)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Sore Throats (except strep)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Bronchitis (in otherwise healthy children and adults)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Runny Nose (with green or yellow mucus)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No
Fluid in the Middle Ear (otitis media with effusion)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No



(Centers for Disease Control and Prevention)

Prevention PLUS!

Influenza Vaccination

Why do we hear about the influenza vaccine every year? Who should get the flu vaccine? Complications of influenza can be serious or fatal; on average influenza kills 36,000 Americans a year. All persons are considered at risk and should receive the vaccine, including children 6 months to 18 years. The vaccine formula is different every year because the virus strains are different. Therefore, the immunity an individual has one year may not protect against a different strain that emerges the following year. The influenza vaccine does not necessarily prevent flu infection but does reduce the severity of symptoms and signs.

There are approximately 8.7 million cases of TB and 1.4 million deaths from TB worldwide each year. Risk factors include having a weakened immune system, substance abuse, tobacco use, being a health care worker, and living in a residential care facility.

Not everyone who gets infected with *Mycobacterium tuberculosis* gets sick. In a latent TB infection, the immune system is able to stop the bacteria from growing. People with a latent TB infection are asymptomatic and cannot spread the infection to others. However, the bacteria can become active and multiply



Figure 8–9 ► Pneumonia patient's chest x-ray. Note the irregular areas of density.

Healthy Aging

Pneumonia Vaccine

Pneumococcal polysaccharide vaccine (PPSV) protects against 23 types of pneumococcal bacteria, including those most likely to cause serious disease. The vaccine is recommended for all adults age 65 and older. In the United States, only about 60% of those age 65 and older have been vaccinated.

and the person goes from having latent TB to TB disease.

When the bacteria are active or multiplying in the body, the person is said to have TB disease. People with TB disease are symptomatic and can spread the bacteria to others. Signs and symptoms of TB disease include a bad cough that lasts 3 weeks or longer, pain in the chest, coughing up blood or sputum, weakness or fatigue, weight loss, no appetite, chills, fever, and night sweats. Auscultation may reveal diminished breath sounds and crackles.

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis*. The bacteria are spread through microscopic droplets released into the air when someone with the untreated, active form of tuberculosis coughs, speaks, sneezes, spits, laughs, or sings. People nearby may breathe in these bacteria and become infected. Inhaled bacteria infect the lungs and induce a chronic inflammatory response that leads to necrosis or tissue death. The tissue in this site becomes soft and cheeselike, which is why it is described as a **caseous** lesion. Lung tissue heals with fibrosis and calcification or scarring, walling off the bacteria into pockets for months or years. These lesions, visible on x-ray, are called **tubercles**.

Diagnosis of TB is based on medical history, physical examination, a test for TB infection (TB skin test or TB blood test), chest x-ray, and sputum smear. In the Mantoux skin test for TB infection, antigens from the bacteria are injected beneath the skin (Figure 8–10 ►). If the person was previously exposed to TB, the skin swells with slight elevation at the injection site. The test is read within 48–72 hours by a trained



Figure 8-10 ► Mantoux tuberculin skin test.

health care worker, who looks for a reaction (induration) on the arm. The TB blood test measures the patient's immune system reaction to *M. tuberculosis*.

TB is treated with antibiotics. The exact drugs and length of treatment depend on the patient's age, overall health, possible drug resistance, the form of TB (latent or active), and the infection's location in the body. The United States does not vaccinate for TB because the incidence is low and screening is more reliable. Vaccines are used in other countries where the prevalence and risk is much higher. In addition to vaccination, prevention of TB includes isolation of contagious patients, TB treatment for those with latent TB infections so they do not get TB disease and become contagious, and practicing proper respiratory hygiene.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disease characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases. Generally, two distinct diseases fall into the category of COPD: emphysema and chronic bronchitis. COPD is the third leading cause of death in the United States. An estimated 12 million people in the United States and 52 million people worldwide have been diagnosed with COPD.

Risk factors for COPD include exposure to tobacco smoke, occupational exposure to dust

and chemicals, and genetics (alpha-1-antitrypsin deficiency). Signs and symptoms include dyspnea, frequent coughing, wheezing, tachypnea, and tightness in the chest. Auscultation may reveal wheezing or crackles and decreased breath sounds. The percussion note is hyperresonance. The main cause of COPD is tobacco use. Breathing in secondhand smoke, air pollution, or chemical fumes or dust from the environment or workplace can also contribute to COPD.

COPD is diagnosed based on medical history, physical examination, pulmonary function test (spirometry), chest x-ray, CT scan, and arterial blood gas analysis. Treatment for COPD includes smoking cessation, bronchodilators to relax the muscles around the airways, inhaled steroids to decrease inflammation, supplemental oxygen, pulmonary rehabilitation, and in rare cases surgery (lung reduction surgery to remove damaged lung tissue, lung transplant). The goal of a pulmonary rehabilitation program is to improve the quality of life for people with chronic breathing problems. Pulmonary rehabilitation includes medical management, exercise, learning new breathing techniques, education, emotional support, and nutritional counseling.

COPD has a clear cause and a clear path of prevention. The vast majority of cases are directly related to cigarette smoking, and the best way to prevent COPD is to never smoke or to stop smoking.

Emphysema Emphysema is a long-term, progressive obstructive lung disease in which the alveoli that promote oxygen exchange between the air and the bloodstream are destroyed. This causes increased shortness of breath and a loss of elasticity in the alveolar walls that have not been destroyed. Emphysema affects about 5 million people in the United States. The risk factors for emphysema include smoking, exposure to secondhand smoke, occupational exposure to dust and chemicals, and genetics (alpha-1-antitrypsin deficiency).

In emphysema, the alveolar walls break down, adjacent alveoli fuse, and the lungs lose their elasticity and surface area required for normal gaseous exchange. Air cannot be adequately exhaled to allow oxygen to enter, and the lungs become filled with air that is high in carbon dioxide.

Emphysema signs and symptoms vary from mild to severe and include dyspnea and coughing. Auscultation may reveal decreased breath sounds, crackles, and wheezing. The percussion note is hyperresonant. Other signs and symptoms may include cyanosis, edema of the feet and ankles, fatigue, headache (especially in the morning), and wheezing. Emphysema patients may develop barrel chest caused by enlargement of the lungs and chest wall and the ineffective use of breathing muscles. As emphysema progresses, many patients experience dyspnea from the slightest activity or even while sedentary. They often exhibit pursed-lip breathing or exhaling through puckered lips, which is a way to make each breath more effective by tending to hold the airways open so that more air can be exhaled. Patients may also have a tendency to lean forward and support themselves with their arms on a surface in front of them or on their knees. This position can help make breathing easier by allowing patients to use accessory breathing muscles (i.e., muscles in the back, abdomen, or neck that are not normally used during breathing) more effectively.

In the vast majority of people, smoking is the cause of emphysema. Exactly how smoking destroys the air sac linings in the lungs isn't known. Familial emphysema is inherited and involves a genetic deficiency of alpha-1-antitrypsin, which leaves the lungs susceptible to alveolar destruction. Because the onset of the disease is gradual, many cases are not diagnosed until irreversible damage has occurred. Diagnosis of emphysema may include medical history, physical examination, blood tests (complete blood count and arterial blood gases), imaging tests (chest x-ray and CT scan), and pulmonary function tests (spirometry and peak flow).

Emphysema is an irreversible condition. The goals of treatment are to reduce symptoms and to slow progression of the disease. The most important step is smoking cessation. Treatment may also include bronchodilators, inhaled steroids, an alpha-1 protease inhibitor for patients with familial emphysema, supplemental oxygen, and surgery (lung reduction to remove damaged tissue or lung transplant). The most effective way to prevent emphysema is to not smoke, avoid exposure to secondhand smoke, and avoid occupational exposure to dust and chemicals.

Chronic Bronchitis Chronic bronchitis is a chronic inflammation of the bronchi. There are two types of bronchitis: acute and chronic. Acute bronchitis comes on quickly and lasts 2–3 weeks. Chronic bronchitis is defined as having a cough with sputum production that lasts at least 3 months for 2 consecutive years. Over 10 million people in the United States are diagnosed with chronic bronchitis each year. Risk factors for chronic bronchitis include tobacco use, exposure to secondhand tobacco smoke, exposure to irritants on the job, and decreased immunity.

Excessive secretion of mucus blocks airflow through the bronchi. Membrane swelling and excess mucus reduce the person's ability to obtain enough oxygen and results in **hypoxia**, a condition of insufficient oxygenation of the tissues. The blocked airways also become susceptible to infections. Over time, untreated chronic bronchitis leads to scarring, destruction of cilia, and tissue death.

Signs and symptoms of chronic bronchitis include mucus-producing cough, wheezing, fatigue, slight fever, chills, and chest discomfort. Auscultation may reveal decreased breath sounds, wheezing, and crackles. The percussion note will be normal to hyperresonant. Cigarette smoking is the most common cause of chronic bronchitis. People exposed to industrial dusts and fumes in the workplace, such as coal miners, grain handlers, and metal molders, are also at high risk of developing the disease. Diagnosis is based on medical history, physical examination, chest x-ray, pulmonary function testing (spirometry), and sputum analysis.

There is no cure for chronic bronchitis. The goal of therapy for chronic bronchitis is to relieve symptoms, prevent complications, and slow the progression of the disease. Quitting smoking is also essential for patients with chronic bronchitis. Treatment may include bronchodilator medications, inhaled steroids, antibiotics, oxygen therapy, pulmonary rehabilitation, and surgery (lung reduction surgery to remove damaged lung tissue, lung transplant). Prevention includes never smoking or quitting smoking, wearing a mask over your mouth and nose when using lung irritants (paint, paint remover, or varnish), frequent handwashing to reduce exposure to viruses and bacteria, and getting the seasonal flu vaccine.

Promote Your Health

Smoking Cessation

The immediate health benefits of quitting smoking are substantial:

- Heart rate and blood pressure, which are abnormally high while smoking, begin to return to normal.
- Within a few hours, the level of carbon monoxide in the blood begins to decline. (Carbon monoxide reduces the blood's ability to carry oxygen.)
- Within a few weeks, people who quit smoking have improved circulation, produce less phlegm, and don't cough or wheeze as often.
- Within several months of quitting, people can expect substantial improvements in lung function.
- In addition, people who quit smoking will have an improved sense of smell, and food will taste better.

Asthma

Asthma is a condition in which the bronchial tubes in the lungs react to certain stimuli by becoming inflamed (Figure 8–11 ►). More than 25 million Americans suffer from asthma, including over 8% of adults and over 9% of children. Risk

factors include a family history of asthma and exposure to certain irritants known as triggers.

The etiology of asthma is idiopathic. People with asthma have very sensitive airways that react and narrow in response to many different substances, activities, and conditions that, in these persons, cause asthma signs and symptoms to start or worsen. The following are common triggers for asthma: indoor and outdoor allergens, tobacco smoke, chemical irritants, cold air, extreme emotional arousal, certain medications (aspirin and other nonsteroidal anti-inflammatories and beta blockers), and physical exercise.

Asthma diagnosis is based on signs and symptoms, medical history, physical examination, pulmonary function tests (spirometry, peak flow, and bronchial provocation), chest x-ray, and allergy testing. Signs and symptoms of asthma include dyspnea, tightness in the chest, coughing, and wheezing. Auscultation may reveal decreased breath sounds and wheezing. During normal breathing, the bands of muscle that surround the airways are relaxed, and air moves freely. In people with asthma, however, allergy-causing substances and other triggers make the bands of muscle surrounding the airways tighten so that air cannot move freely. This causes the asthmatic to feel short of breath, and the air moving through the tightened airways causes a wheezing sound. Fortunately, this airway narrowing is reversible, a feature that distinguishes asthma from other lung diseases such as bronchitis or emphysema.

An asthma attack is defined as a sudden worsening of asthma signs and symptoms. Prolonged

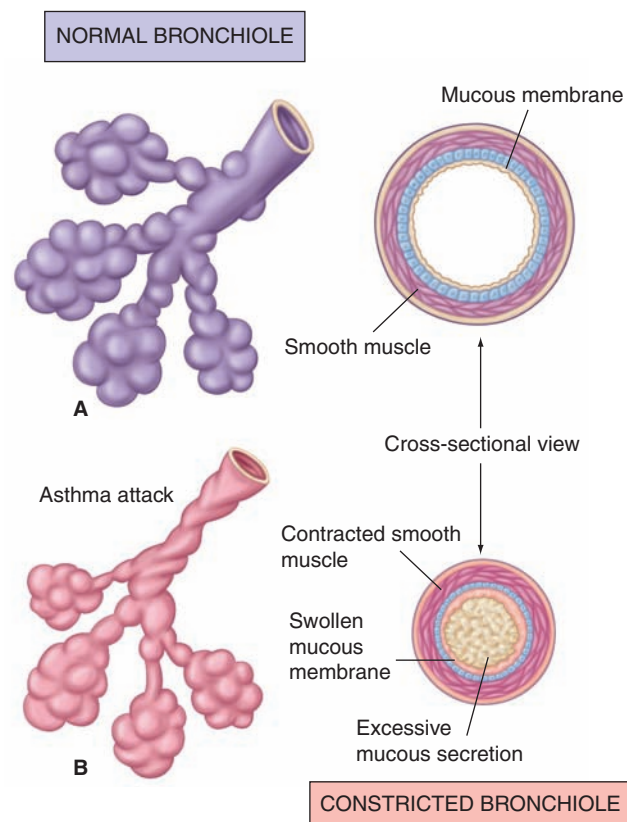


Figure 8–11 ► (A) Normal bronchiole and (B) bronchiole constricted in asthma attack.

asthma attacks that do not respond to treatment are a medical emergency.

There are two basic types of medications used in asthma treatment: steroids and other anti-inflammatory medications and bronchodilators. Anti-inflammatory medications, particularly inhaled steroids, are the most important treatment for most people with asthma. These medications reduce swelling and mucus production in the airways. This makes the airways less sensitive and less likely to react to triggers.

Bronchodilators relax the muscles that can tighten around the airways and help to open them up. Short-acting bronchodilator inhalers are often referred to as rescue inhalers and are used to quickly relieve the signs and symptoms of asthma. Long-acting bronchodilators are used in combination with inhaled steroids when there are ongoing asthma signs and symptoms despite treatment with a daily inhaled steroid. Asthma inhalers are the most common and effective way to deliver asthma drugs to the lungs. A nebulizer uses a mouthpiece and changes asthma medications from liquid form to a mist so they can be more easily inhaled into the lungs (Figure 8–12 ►).

A peak flow meter can be used to assess how open a patient's airways are. A peak flow meter may help determine when an asthma attack is starting, identify asthma triggers, decide if an asthma attack is under control, and help determine when to seek emergency care.

Asthma cannot be prevented. However, asthma can be managed by identifying and

avoiding asthma triggers, taking medication as prescribed, and obtaining continued monitoring by a physician.

Cystic Fibrosis

Cystic fibrosis (CF) is an inherited disease affecting the exocrine glands of the lungs and pancreas, causing these glands to secrete excessive thick mucus. CF affects about 30,000 children and adults in the United States and about 70,000 children and adults worldwide. Risk factors for CF include a family history of CF and being of Northern European or Central European descent.

People with CF have a higher than normal level of salt in their sweat; therefore, they have very salty-tasting skin. The thick, sticky mucus secreted in the lungs causes dyspnea, wheezing, and a persistent cough with thick sputum. The abnormally thick mucosal surface increases susceptibility to recurrent lung infections. **Bronchiectasis**, or weakened and dilated bronchial tubing, is a common complication or aftermath of cystic fibrosis.

Excessive mucus also blocks the ducts of the pancreas, preventing the release of digestive enzymes and resulting in weight loss and malnutrition. The lack of proper fat digestion results in a large, bulky, foul-smelling stool. Pancreatic glands become dilated and develop into cysts containing thick mucus. Cystic fibrosis gets its name from the fibrous tissue that forms around these cysts.



A



B

Figure 8–12 ► (A) Nebulizer and (B) inhaler medication delivery devices for asthma medications. (<http://visualonline.cancer.gov/details.cfm?imageid=2348>)

CF is an autosomal recessive inherited disease. All newborns in the United States are screened for CF. A blood sample is checked for higher than normal levels of immunoreactive trypsinogen (IRT) released by the pancreas. If the ITR level is high, CF is confirmed with a genetic test or sweat test. In CF genetic testing, DNA samples from blood or saliva are checked for specific defects on the gene responsible for CF. In a sweat test, a sweat-producing chemical is applied to a small area of the skin. The sweat is then collected to see if it is saltier than normal.

There is no cure for CF, but treatment can ease signs and symptoms and reduce complications. Treatment includes chest physical therapy and exercise to loosen mucus so it can be coughed up, nutritional therapy, mucus-thinning medications to reduce the stickiness of mucus and loosen it, anti-inflammatory medication to reduce swelling in the airways caused by recurrent infections, and bronchodilators to open the airways by relaxing the muscles around them. CF is not preventable.

Pleurisy or Pleuritis

Pleurisy is an inflammation of the pleural membranes that line the chest wall and encase each lung. The incidence of pleurisy is not known. Risk factors include lung infection, chest trauma, and pulmonary embolism. The main symptom of pleurisy is a sharp chest pain that worsens with breathing in or coughing caused by the inflamed pleura layers rubbing together. Pleurisy may also cause dyspnea and tachypnea. Auscultation reveals a pleural rub.

As the risk factors just mentioned indicate, pleurisy is often caused by a lung infection. It can also be caused by chest trauma, pulmonary embolism, or be idiopathic. Diagnosis is based on signs and symptoms, physical examination, blood tests for pathogens, and imaging tests. In some cases pleural fluid and tissue will be removed for testing. The treatment of pleurisy depends on the cause and may include antibiotics if pleurisy is caused by a bacterial infection as well as over-the-counter or prescription nonsteroidal anti-inflammatory medication for pain relief. Prevention includes seeking medical attention early for lung infections and getting the pneumonia vaccine if recommended.

Pneumothorax

Pneumothorax is a collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse. Normally, the pressure in the lungs is greater than the pressure in the pleural space surrounding the lungs. However, if air enters the pleural space, the pressure there then becomes greater than the pressure in the lungs, causing the lung to collapse partially or completely. The incidence of pneumothorax is estimated to be 7.4–18 cases per 100,000. Risk factors for pneumothorax include being male, smoking, being tall and underweight, having certain lung diseases, and a history of pneumothorax.

Signs and symptoms include a sudden, sharp pain on the same side as the affected lung and dyspnea. Auscultation may reveal diminished or absent breath sounds on the affected side. The percussion note is tympanic. Pneumothorax can be caused by injury to the chest, damage to the lungs caused by an underlying lung disease (emphysema, TB, CF, pneumonia, lung cancer), or rupture of air-filled blisters (blebs) found in the lungs of some people who are tall and underweight. The blebs can spontaneously rupture or can rupture due to a change in air pressure (e.g., scuba diving, flying, mountain climbing). Pneumothorax can also be idiopathic.

Pneumothorax is diagnosed by physical examination, arterial blood gas analysis, and imaging tests. If a small portion of the lung is collapsed, monitoring the condition may be adequate. If a larger area of the lung is collapsed, a needle or chest tube is inserted into the chest cavity to relieve the pressure on the lung, allowing the lung to reexpand. In some cases, surgery may be required to close the leak. Prevention includes smoking cessation and seeking medical attention for respiratory problems.

Atelectasis

Atelectasis is a collapse of lung tissue affecting part or all of one lung. The alveoli in that part of the lung no longer fill with air. As a result, they can't take part in gas exchange. The incidence of atelectasis is not known. Risk factors for atelectasis include anesthesia, prolonged bed rest with few changes in position, shallow breathing, and underlying lung disease. If only a small area or a few small areas of lung are affected, there may be no signs or symptoms because the rest of the lung

can bring in enough oxygen to make up for the collapsed part. Signs and symptoms include dyspnea, chest pain, cyanosis, and coughing. Auscultation may reveal diminished or absent breath sounds on the affected side. The percussion note is dull.

Atelectasis may be caused by a blockage of the bronchus or bronchioles or by pressure on the lung. A mucus plug is the most common cause of atelectasis. Drugs given during surgery make the lungs inflate less fully than usual, so normal secretions collect in the airways. Suctioning the lungs during surgery helps clear away these secretions, but they may continue to build up afterward. Mucus plugs are also common in people with cystic fibrosis and during severe asthma attacks. Diagnosis is based on medical history, physical examination, and chest x-ray.

Treatment may include aerosolized respiratory treatments to open the airway; positioning the body on the unaffected side to allow the affected lung to reexpand; removing obstructions by bronchoscopy; breathing exercises, clap, or percussion on the chest to loosen mucus; tilting the body (postural drainage) so that the head is lower than the chest to drain mucus; and treating a tumor or underlying condition, if present. Prevention includes encouraging movement and deep breathing in anyone who is bedridden for long periods, keeping small objects out of the reach of young children, and maintaining deep breathing after anesthesia.

Pulmonary Embolism

Pulmonary embolism (PE) is a blockage in one or more arteries of the lungs. The incidence of PE is not known but estimates range from 300,000 to 600,000 people per year. Risk factors for PE include prolonged immobility, having major surgery, hip or leg fractures, having a family history of PE, cancer, smoking, obesity, a history of heart attack or stroke, pregnancy, taking birth control pills, or hormone therapy.

Signs and symptoms may include sudden dyspnea, tachypnea, chest pain, and a cough that may produce bloody or blood-streaked sputum. In most cases PE is caused by a blood clot in the leg that breaks loose and travels to the lungs. Diagnosis may include medical history, physical examination (in approximately half of patients with PE,

auscultation reveals crackles and pleural rub in the area of the embolism), and imaging tests.

Anticoagulants are the most common treatment; if the condition is life-threatening, clot dissolvers or surgery may be necessary. Prevention includes actions that prevent clot formation in the legs, including avoiding sitting for long periods of time, getting mobile as soon as possible after surgery, wearing elastic compression stockings, and drinking plenty of fluids when traveling to prevent dehydration, which tends to increase blood clot formation.

Lung Cancer

Lung cancer is a malignant neoplasm arising in lung tissue. Lung cancer is the leading cause of cancer death among men and women in the United States. The American Cancer Society estimates that in 2013 approximately 228,190 cases of lung cancer will be diagnosed and 159,480 people will die from lung cancer in the United States. The average age of diagnosis is 70. Risk factors include smoking, exposure to secondhand smoke, age (over 65), exposure to asbestos or radon, genetics, and a family history of lung cancer.

Lung cancer is classified into two basic types depending on the appearance of the lung tissue under a microscope. Non-small cell lung cancer (NSCLC) accounts for 80% of lung cancers, while small cell lung cancer accounts for the remaining 20%. Signs and symptoms of lung cancer develop slowly. Few symptoms or signs accompany early-stage lung cancer. When signs and symptoms begin, they are usually a result of blocked breathing passages or the spread of the cancer. Signs and symptoms may include coughing, chest pain, and hemoptysis. The blood in the sputum results from erosion of blood vessels by the growing malignancy. Other signs and symptoms include dyspnea and wheezing caused by airway obstruction from compression by tumors and body fluids such as mucus and blood. Anorexia, weight loss, and weakness accompany the disease, caused partly by poor oxygenation of the blood.

Smoking causes the great majority of lung cancers; 90% of lung cancers are a result of tobacco use. Tobacco smoke contains over 4,000 chemical compounds, many of which have been shown to be cancer causing, or carcinogenic.



Figure 8–13 ► Chest x-ray of lung cancer; cancer is seen on the left side.

Cancer is diagnosed by medical history, physical examination, imaging tests (Figure 8–13 ►), and sputum cytology. A biopsy confirms the occurrence and identifies the type of lung cancer. Treatment includes surgery, chemotherapy, radiation, and targeted therapy that decreases the growth of tumor cells. Lung cancer can be prevented by not smoking, quitting smoking, avoiding secondhand smoke, testing for radon, and avoiding exposure to carcinogens at work.

Age-Related Diseases

In older adults, elastic tissue of the lungs deteriorates and reduces lung capacity. Weakening respiratory muscles and arthritis in joints of the rib cage and vertebrae impair respiratory function. This can cause labored breathing in older adults, especially if they have led a sedentary lifestyle. Regular exercise can

maintain or improve lung capacity. The cough reflex decreases with age, enabling pathogens, irritants, and debris to reach deep into the lungs. This increases susceptibility to respiratory infections. Pneumonia is a common cause of death in older adults who suffer from other chronic diseases.

Some degree of emphysema occurs in many individuals age 50–70. On average, one square foot of the respiratory membrane is lost each year after age 30. Aerobic exercise or walking keeps lungs and airways healthy. The incidence of lung cancer increases with age. However, the cancer probably begins earlier in life, and this incidence reflects the relatively late age at diagnosis. Earlier treatment is crucial for a better prognosis and longevity.

Resources

- American Cancer Society: www.cancer.org
- American Lung Association: www.lung.org
- American Lung Association. *Trends in COPD (Chronic Bronchitis and Emphysema): Morbidity and Mortality*. www.lung.org/finding-cures/our-research/trend-reports/copd-trend-report.pdf.
- American Thoracic Society: www.thoracic.org
- Centers for Disease Control and Prevention: www.cdc.gov
- Centers for Disease Control and Prevention. *Data & Statistics*. www.cdc.gov/DataStatistics/.
- Cystic Fibrosis Foundation: www.cff.org/aboutcf
- Environmental Protection Agency: www.epa.gov
- Lalley PM. The Aging Respiratory System—Pulmonary Structure, Function and Neural Control. *Respiratory Physiology and Neurobiology* 2013;187(3):199–210.
- National Heart, Lung, and Blood Institute: www.nhlbi.nih.gov
- Noppen M. Spontaneous Pneumothorax: Epidemiology, Pathophysiology and Cause. *European Respiratory Review* 2010;19(117):217–219.
- Sharma G, Goodwin J. Effect of Aging on Respiratory System Physiology and Immunology. *Clinical Interventions in Aging* 2006;1(3):253–260.
- World Health Organization: www.who.int

Diseases at a Glance

Respiratory System

Disease	Etiology	Signs and Symptoms
Common cold	Viral infection	Sore throat, runny nose, sneezing, cough
Allergic rhinitis	Hypersensitivity to an allergen	Runny nose, congestion, watery eyes, sneezing
Sinusitis	Viral infection	Facial pain and pressure, nasal stuffiness, nasal discharge, loss of smell, cough or congestion
Tonsillitis	Bacterial or viral infection	Severe sore throat; red, swollen tonsils; difficulty or painful swallowing; white or yellow patches on the tonsils; fever
Pharyngitis	Viral or bacterial infection	Sore throat, fever, headache, swollen lymph nodes in the neck, joint pain or muscle aches
Laryngitis	Hoarse or raspy voice, difficulty swallowing, throat pain, fever	Viral infection; overuse of the voice, bacterial infection
Influenza	Infection with the influenza virus	Fever, cough, muscle or body aches, headache, fatigue, chest discomfort, extreme exhaustion at the beginning of the illness
Pneumonia	Bacterial or viral infection	Cough (may cough up mucus or blood), fever, chills, dyspnea, chest pain

Diagnosis	Treatment	Prevention
Physical examination, signs and symptoms	Symptomatic including pain relievers, decongestants, antihistamines, cough suppressants	Avoiding close contact with anyone with a cold, practicing regular handwashing and proper respiratory hygiene
Physical examination, medical history, allergy testing	Avoiding the allergen, nasal steroids, antihistamines, decongestants, allergy shots	Allergic rhinitis can be avoided by avoiding exposure to the allergens, but otherwise it is not preventable
Medical history, physical exam, imaging tests, nasal and sinus cultures, allergy testing	Symptomatic may include using a saline nasal spray, nasal corticosteroids, decongestants, pain relievers	Avoiding upper respiratory infections, managing allergies, avoiding smoke and pollutants, using a humidifier
Visual examination of the tonsils, rapid strep test, throat culture	Bacterial infection—antibiotics Viral infection—symptomatic including pain relievers, rest, fluids, surgery to remove tonsils	Avoiding close contact with anyone with a respiratory infection, practicing proper respiratory hygiene, frequent handwashing
Physical examination, rapid strep test or throat culture	Viral infection—symptomatic including gargling with salt water, anti-inflammatory medications, pain relievers Bacterial infection—antibiotics	Practicing proper respiratory hygiene, avoiding close contact with anyone with a respiratory infection, frequent handwashing
Signs and symptoms, physical examination, laryngoscopy	Resting the voice, controlling heartburn, reducing exposure to alcohol or cigarette smoke	Frequent handwashing, avoiding people with respiratory infections, practicing proper respiratory hygiene, not smoking, limiting exposure to secondhand smoke
Signs and symptoms	Antiviral medications, acetaminophen, cough suppressant	Avoiding close contact with people who have the flu; frequent handwashing; avoiding touching your eyes, nose, and mouth; practicing proper respiratory hygiene; flu vaccine
Medical history, physical examination, sputum culture	Bacteria—antibiotics Viral pneumonia—rest, oxygen therapy, increased fluid intake, pain relievers, high-calorie diet	Vaccination (seasonal flu shot, pneumococcal), frequent handwashing, practicing proper respiratory hygiene, not smoking

Disease	Etiology	Signs and Symptoms
Tuberculosis	<i>Mycobacterium tuberculosis</i>	Latent TB—asymptomatic TB disease—bad cough that lasts 3 weeks or longer, pain in the chest, coughing up blood or sputum, weakness or fatigue, weight loss, no appetite, chills, fever, night sweats
COPD	Tobacco use	Dyspnea, frequent coughing, wheezing, tachypnea, tightness in the chest
Chronic bronchitis	Cigarette smoking is the most common cause of chronic bronchitis. People exposed to industrial dusts and fumes in the workplace—such as coal miners, grain handlers, and metal molders—are also at high risk of developing the disease.	Mucus-producing cough, wheezing, fatigue, slight fever, chills, chest discomfort
Emphysema	In the vast majority of people, smoking is the cause of emphysema. An inherited form involves a genetic deficiency of an enzyme known as alpha-1-antitrypsin.	Dyspnea, coughing, cyanosis, edema of the feet and ankles, fatigue, headache (especially in the morning), wheezing, barrel chest
Asthma	Idiopathic	Shortness of breath, tightness in the chest, coughing, wheezing
Cystic fibrosis	Autosomal recessive inherited disease	Salty-tasting skin, dyspnea, wheezing, persistent cough with thick sputum, recurrent lung infections, weight loss and malnutrition, a large, bulky, foul-smelling stool
Pleurisy	Lung infection, chest trauma, pulmonary embolism, idiopathic	Sharp chest pain that worsens with breathing in or coughing, dyspnea, tachypnea

Diagnosis	Treatment	Prevention
Medical history, physical examination, a test for TB infection (TB skin test or TB blood test), chest x-ray, sputum smear	Antibiotics	Vaccination, includes isolation of contagious patients, TB treatment for those with latent TB, practicing proper respiratory hygiene
Medical history, physical examination, spirometry test, chest x-ray, CT scan, arterial blood gas analysis	Smoking cessation, inhaled steroids, oxygen therapy, pulmonary rehabilitation, surgery	Never smoking or quitting smoking
Medical history, physical examination, chest x-ray, spirometry test, sputum smear	Smoking cessation, bronchodilator medications, inhaled steroids, antibiotics, oxygen therapy, pulmonary rehabilitation, surgery	Never smoking or quitting smoking, wear a mask over your mouth and nose when using lung irritants, frequent handwashing to reduce exposure to viruses and bacteria, getting the seasonal flu vaccine
Medical history, physical examination, blood tests (complete blood count and arterial blood gases), imaging tests (chest x-ray and CT scan), pulmonary function tests (spirometry and peak flow)	Smoking cessation, bronchodilators, inhaled steroids, alpha-1 protease inhibitor, supplemental oxygen, surgery	Never smoking and avoiding exposure to secondhand smoke, occupational exposure to dust and chemicals
Signs and symptoms, medical history, physical examination, pulmonary function tests (spirometry, peak flow, and bronchial provocation), chest x-ray, allergy testing	Steroids and other anti-inflammatory drugs, bronchodilators	Not preventable
Newborns are screened via immuno-reactive trypsinogen test. CF diagnosis is confirmed with a genetic test or sweat test	Chest physical therapy, nutritional therapy, mucus-thinning medications, anti-inflammatories	Not preventable
Signs and symptoms, physical examination, blood tests for pathogens, imaging tests	Antibiotics, over-the-counter or prescription nonsteroidal anti-inflammatory drugs	Seeking medical attention early for lung infections, getting the pneumonia vaccine if recommended

Disease	Etiology	Signs and Symptoms
Pneumothorax	Injury to the chest, damage to the lungs caused by an underlying lung disease, rupture of air-filled blisters, idiopathic	Sudden, sharp pain on the same side as the affected lung, dyspnea
Atelectasis	Blockage of the bronchus or bronchioles or by pressure on the lung	None, dyspnea, chest pain, cyanosis, coughing
Pulmonary embolism	A blood clot in the leg that breaks loose and travels to the lungs	Sudden dyspnea, tachypnea, chest pain, cough that may produce bloody or blood-streaked sputum
Lung cancer	Smoking	Coughing, chest pain, hemoptysis, dyspnea, wheezing, anorexia, weight loss, weakness

Diagnosis	Treatment	Prevention
Physical examination, arterial blood gas analysis, imaging tests	Monitoring the condition may be adequate, a needle or chest tube is inserted into the chest cavity relieving the pressure on the lung allowing the lung to reexpand, surgery	Smoking cessation, seeking medical attention for respiratory problems
Medical history, physical examination, chest x-ray.	Aerosolized respiratory treatments; positioning the body on the unaffected side; removing obstructions, breathing exercises, clap, or percussion; tilting the body so that the head is lower than the chest; treating a tumor or underlying condition	Encouraging movement and deep breathing in anyone who is bedridden for long periods, keeping small objects out of the reach of young children, maintaining deep breathing after anesthesia
Medical history, physical examination, imaging tests	Anticoagulants, clot dissolvers, surgery	Avoiding sitting for long periods of time, getting mobile as soon as possible after surgery, wearing elastic compression stockings, drinking plenty of fluids when traveling
Medical history, physical examination, imaging tests, sputum cytology, biopsy	Surgery, chemotherapy, radiation, targeted therapy	Never smoking, quitting smoking, avoiding secondhand smoke, testing for radon, avoiding exposure to carcinogens at work

Interactive Exercises

Cases for Critical Thinking

1. Sheila just graduated from college and moved into an apartment with a roommate. She is excited because her and her roommate decided to get a cat. Sheila was never allowed to have a pet when she was growing up because her dad has allergies. It has only been a few weeks since they moved in and she is not feeling well. She has a runny nose, is congested, and is sneezing. What disease might Sheila have? What diagnostic procedures would be helpful in diagnosing her disease?
2. Bill just had surgery on a severely broken leg. He has a cast from his hip to his toes. He was in the hospital for about a week and has been home for a few days. Bill's recovery was going well until he suddenly complains of dyspnea and chest pain and is coughing up blood. What disease might Bill have? What is the probable cause of the disease?
3. Sara loved to run. She watched the track meets at school even as a first grader. An asthmatic, she occasionally needed to use an inhaler, but she seemed determined to be an athlete. Should Sara be discouraged from pursuing her goal? Why or why not?

Multiple Choice

1. The lungs are encased by a double membrane consisting of two layers called _____.
 - a. alveoli
 - b. bronchi
 - c. pleura
 - d. atelectasis
2. The etiological agent of influenza is a _____.
 - a. bacterium
 - b. virus
 - c. fungi
 - d. helminth
3. What is an infection in one or both lungs affecting primarily the alveoli?
 - a. chronic bronchitis
 - b. emphysema
 - c. tuberculosis
 - d. pneumonia
4. A long-term, progressive obstructive lung disease in which the alveoli that promote oxygen exchange between the air and the bloodstream are destroyed is called _____.
 - a. pneumonia
 - b. chronic bronchitis
 - c. emphysema
 - d. tuberculosis
5. A condition in which the bronchial tubes in the lungs react to different stimuli by becoming inflamed is _____.
 - a. laryngitis
 - b. asthma
 - c. sinusitis
 - d. emphysema
6. What is a collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse?
 - a. atelectasis
 - b. pneumonia
 - c. emphysema
 - d. pneumothorax
7. What is the leading cause of cancer death among men and women?
 - a. lung
 - b. colon
 - c. pancreatic
 - d. stomach
8. The most common cause of pharyngitis is a _____.
 - a. virus
 - b. bacterium
 - c. fungi
 - d. prion

9. The trachea descends and branches into two primary _____.
 - a. bronchi
 - b. bronchioles
 - c. pleura
 - d. alveoli
10. In this respiratory disease, the alveolar walls break down, adjacent alveoli fuse, and the lungs lose their elasticity and surface area required for normal gaseous exchange.
 - a. chronic bronchitis
 - b. emphysema
 - c. pneumonia
 - d. cystic fibrosis

True or False

- _____ 1. The flu can be prevented by vaccine.
- _____ 2. The common cold is easily treated with antibiotics.
- _____ 3. Laryngitis may be treated by removal of the tonsils.
- _____ 4. The lungs are a common site for metastatic cancer.
- _____ 5. The incidence of tuberculosis is declining because of potent antibiotics.
- _____ 6. Dyspnea is the coughing up of blood.
- _____ 7. The bronchi branch into smaller and smaller tubules called *alveoli*.
- _____ 8. The bronchioles are the site of gas exchange.
- _____ 9. There is a cure for the common cold.
- _____ 10. The bronchial challenge test is used to detect and quantify airway hypersensitivity.

Fill-Ins

1. The _____ test is used to screen for tuberculosis.
2. Normal arterial blood gases should be high in _____ and low in _____.
3. The main cause of lung cancer is _____.
4. _____ is the first and most commonly done lung function test.
5. The common cold and influenza are caused by _____.
6. _____ is a blockage in one or more arteries of the lungs.
7. In the vast majority of people, _____ is the cause of emphysema.
8. Numerous hairlike projections called _____ project from the surface of the pharynx and trachea.
9. The _____ are thin-walled sacs surrounded by blood capillaries and are the site of gas exchange.
10. Excessive and thick mucus is secreted in the inherited disease called _____.

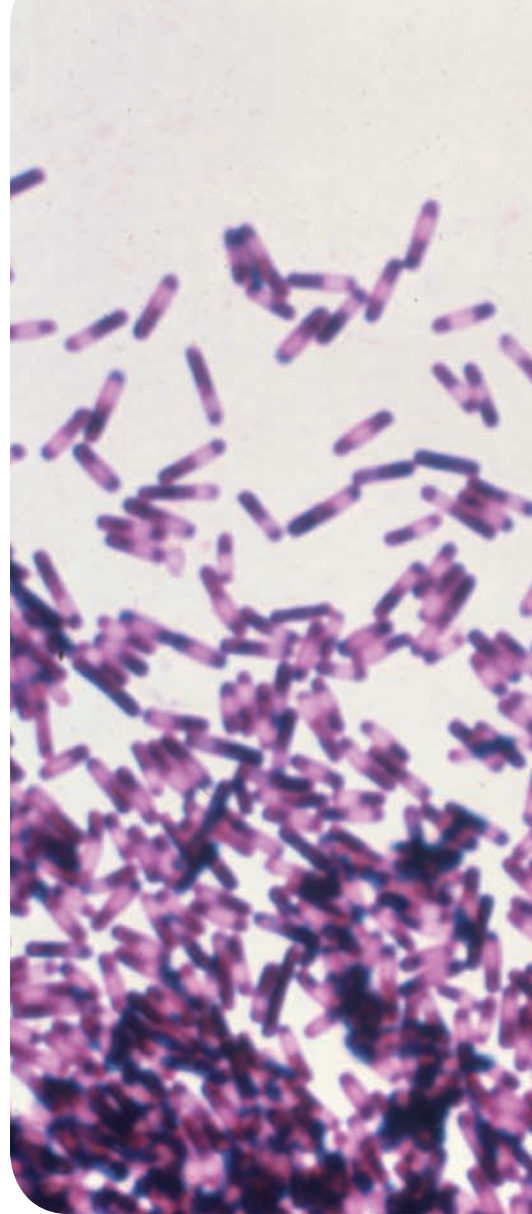
Chapter 9

Diseases and Disorders of the Gastrointestinal System

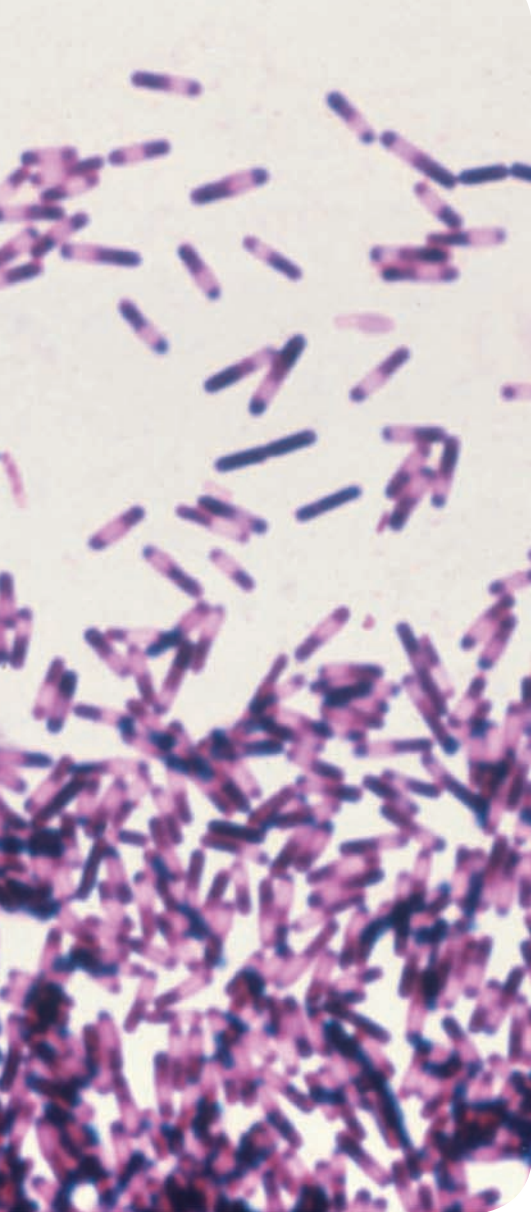
Learning Objectives

After studying this chapter, you should be able to

- Describe the normal structure and function of the digestive tract
- Describe the key characteristics of major diseases of the digestive tract
- Name the diagnostic tests for diseases of the digestive tract
- Explain the etiology of gastrointestinal diseases
- Describe the treatment options for diseases of the digestive tract
- Describe the normal structure and function of the liver, gallbladder, and pancreas
- Describe the key characteristics of major diseases of the liver, gallbladder, and pancreas
- Name the diagnostic tests for diseases of the liver, gallbladder, and pancreas
- Explain the etiology of liver, gallbladder, and pancreas diseases
- Describe the treatment options for diseases of the liver, gallbladder, and pancreas
- Describe age-related diseases of the digestive system



C. difficile is a major cause of pseudomembranous colitis and antibiotic-associated diarrhea. (Courtesy of the Centers for Disease Control and Prevention/Dr. Gilda Jones, 1980)



Disease Chronicle

Dysentery

Diseases of the digestive system include common ailments familiar to nearly everyone. Some are minor annoyances; others are serious, life-threatening diseases. The impact of digestive system diseases is undeniable. During the American Civil War, 81,360 soldiers died from dysentery, while 93,443 were killed in combat. Even today, 18,000 cases of bacillary dysentery occur annually in the United States. Despite modern medical diagnosis and treatment, cancer of the pancreas, colon, and liver remain deadly, and worldwide, dysentery remains a leading cause of death among children.

Fact or Fiction?

Spicy foods cause ulcers.

False: Ulcers are caused by infection with the bacterium *Helicobacter pylori*. These ulcers can be cured with antibiotics. Nonsteroidal anti-inflammatory medications such as aspirin and ibuprofen also cause ulcers.

Anatomy and Physiology Review

The digestive system consists of a digestive tract and accessory organs that assist the digestive process. The digestive tract begins at the mouth

and includes the pharynx, esophagus, stomach, small intestine, and large intestine. The accessory organs include the liver, gallbladder, and pancreas (Figure 9-1 ►).

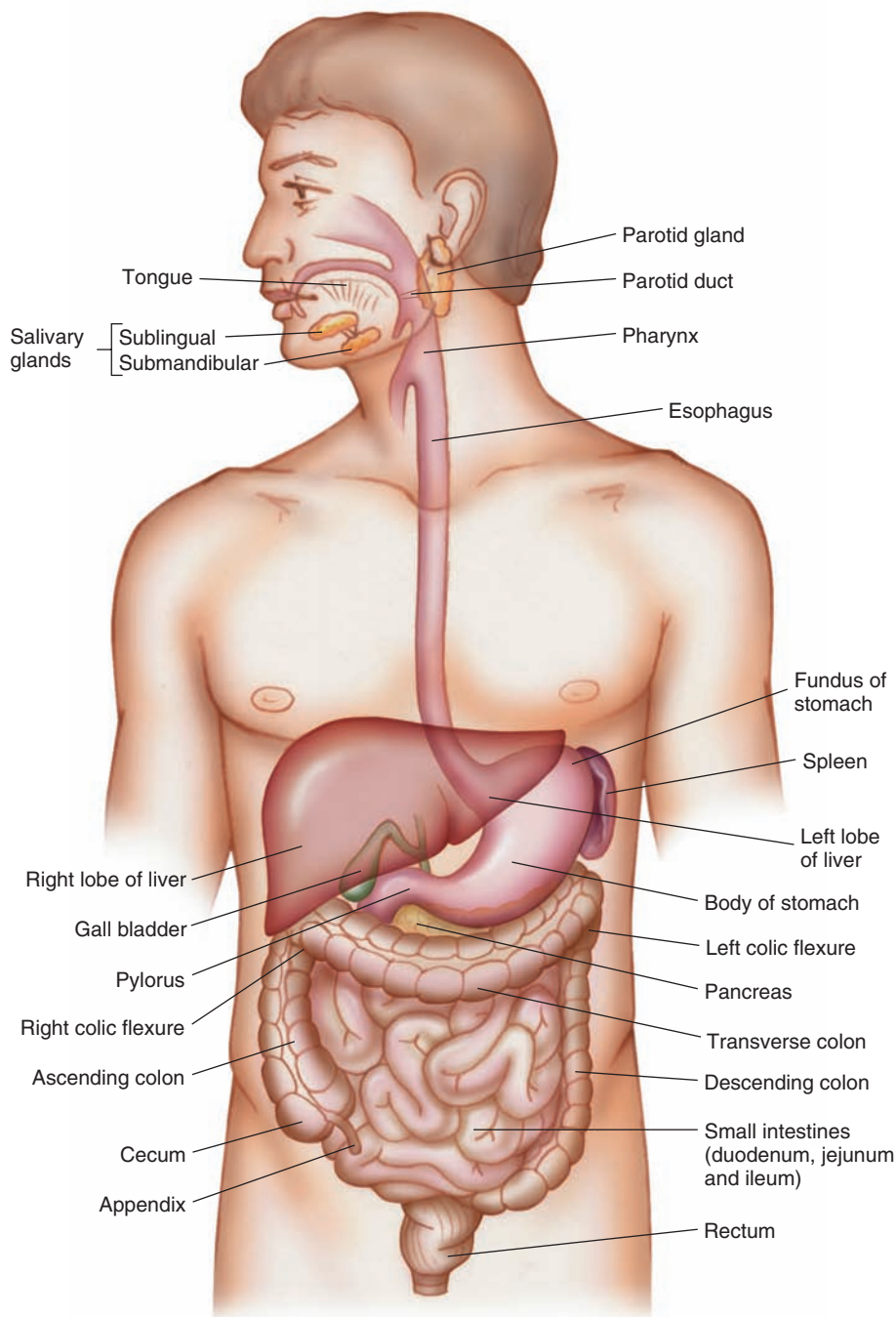


Figure 9-1 ► The gastrointestinal system.

Digestion begins in the mouth with the mechanical breakdown of food. The secretion of saliva moistens the food and provides an enzyme for initial digestion of starch. The food is then swallowed and passes through the pharynx, or throat, and into the esophagus.

The moistened food moves down the esophagus to the stomach. A sphincter muscle at the juncture of the esophagus and stomach prevents regurgitation while digestion continues. The stomach secretes gastric juice that contains enzymes, biological catalysts that act on protein. Gastric juice also contains hydrochloric acid, which activates these enzymes. The acidic gastric contents would be irritating to the stomach lining if the lining were not protected by a thick covering of mucus. A great deal of moistening and mixing occurs within the stomach. The moistened, mixed, and acidic food is called chyme.

Chyme passes from the stomach into the small intestine through a sphincter muscle, the **pyloric sphincter**. This sphincter is closed until it receives nerve and hormonal signals to relax and open. Chyme is propelled along its course by rhythmic, smooth muscle contractions of the intestinal wall called **peristalsis**.

Most digestion occurs in the first part of the small intestine, the **duodenum**. Intestinal secretions contain mucus and digestive enzymes, which enter by means of the pancreatic duct from the pancreas (Figure 9-2 ►). The pancreas is a gland with both endocrine and exocrine functions. The endocrine portion secretes insulin and glucagon. The exocrine portion secretes enzymes that digest protein, lipid, and carbohydrate (Figure 9-3 ►). The exocrine pancreas also secretes an alkaline solution for the neutralization of acid carried into the small intestine from the stomach.

Bile, secreted by the liver and stored in the gallbladder, enters the duodenum through the common bile duct (Figure 9-4 ►). Bile is an emulsifier, a substance that reduces large fat droplets into much smaller fat droplets, enabling the lipid enzymes to digest fat into small, absorbable units.

When digestion is complete, nutrients such as sugars and amino acids are absorbed into blood capillaries and lymph vessels in the intestinal wall. The inner surface of the small intestine is arranged to provide the greatest amount of surface area possible for digestion and absorption. This mucosal surface contains numerous fingerlike projections called villi, each of

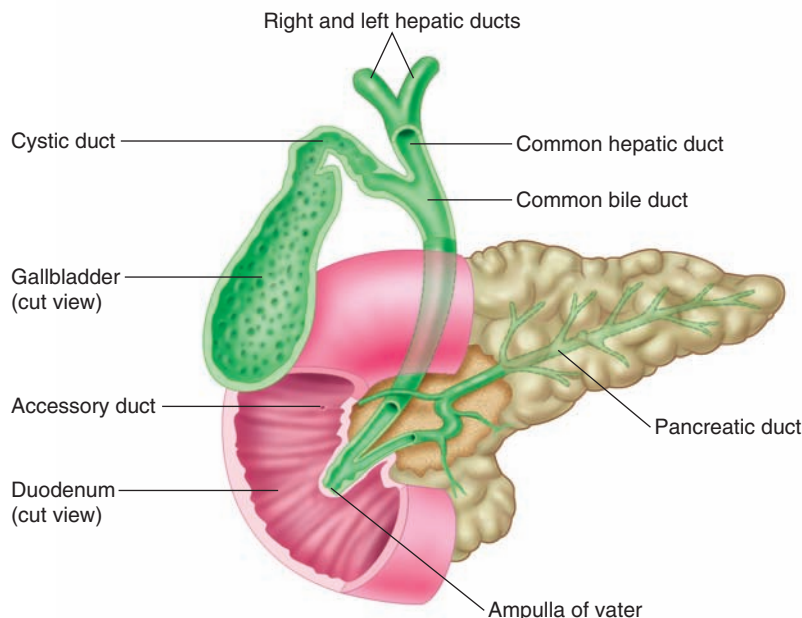


Figure 9-2 ► Relationship between the pancreas and the digestive system.

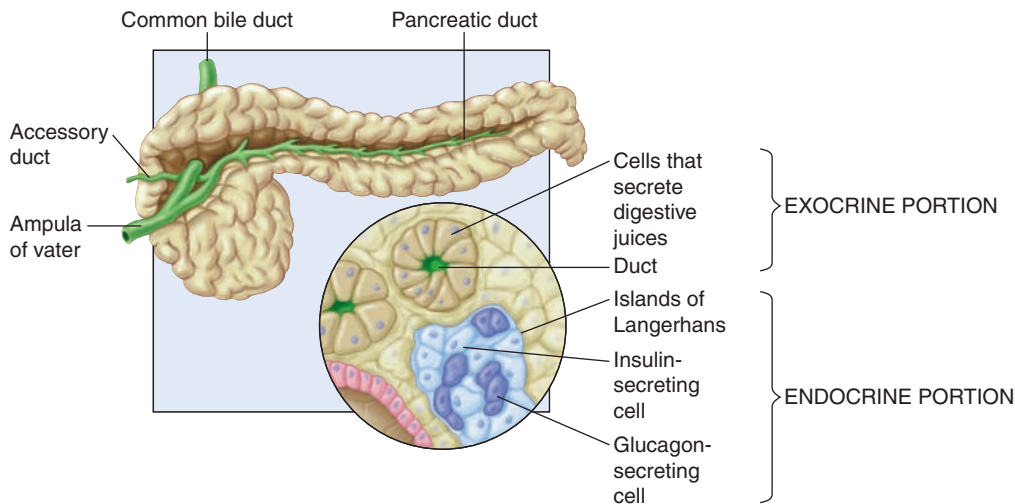


Figure 9-3 ► The pancreas: An endocrine and exocrine gland.

which contains capillaries and lymph vessels for absorption (Figure 9-5 ►).

Material not digested passes into the large intestine, or colon. The first part of the colon is the cecum, to which the appendix, a fingerlike mass of lymphatic tissue, is attached. Water and minerals are absorbed from the large intestine, and the remaining matter is excreted as feces.

In this chapter, the diseases of each part of the digestive system are described. These include diseases of the mouth, esophagus, stomach, small and large intestines, pancreas, liver, and gallbladder.

Diagnostic Tests and Procedures

Diagnosis of digestive system diseases and disorders relies on many types of laboratory tests,

culturing, biopsy, imaging techniques, and other procedures. These are discussed with each of the diseases and disorders in this chapter.

Infectious diseases in the digestive organs can be identified by culture and immunodiagnostic methods. For example, stool culture permits identification of pathogens in the feces. Many abnormalities and infections can be diagnosed using blood tests. For example, blood tests for liver enzymes are used to detect liver abnormalities and liver infections. Biopsy is used to identify several diseases. For example, colon cancer can be identified through biopsy. Malabsorption syndrome can also be identified through biopsy of the intestine's lining. Several digestive system diseases and disorders are diagnosed with CT, x-ray, ultrasound, and MRI. Several types of endoscopy allow visualization

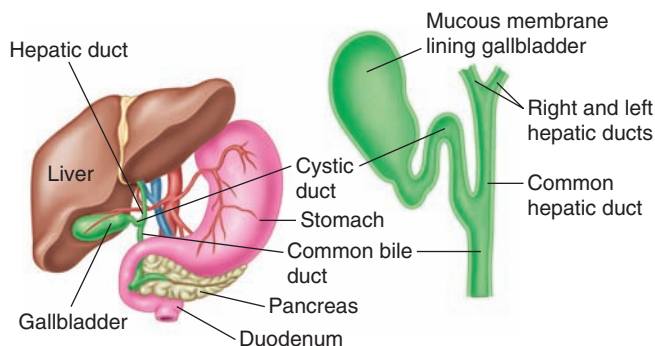


Figure 9-4 ► Bile duct system of the liver and gallbladder.

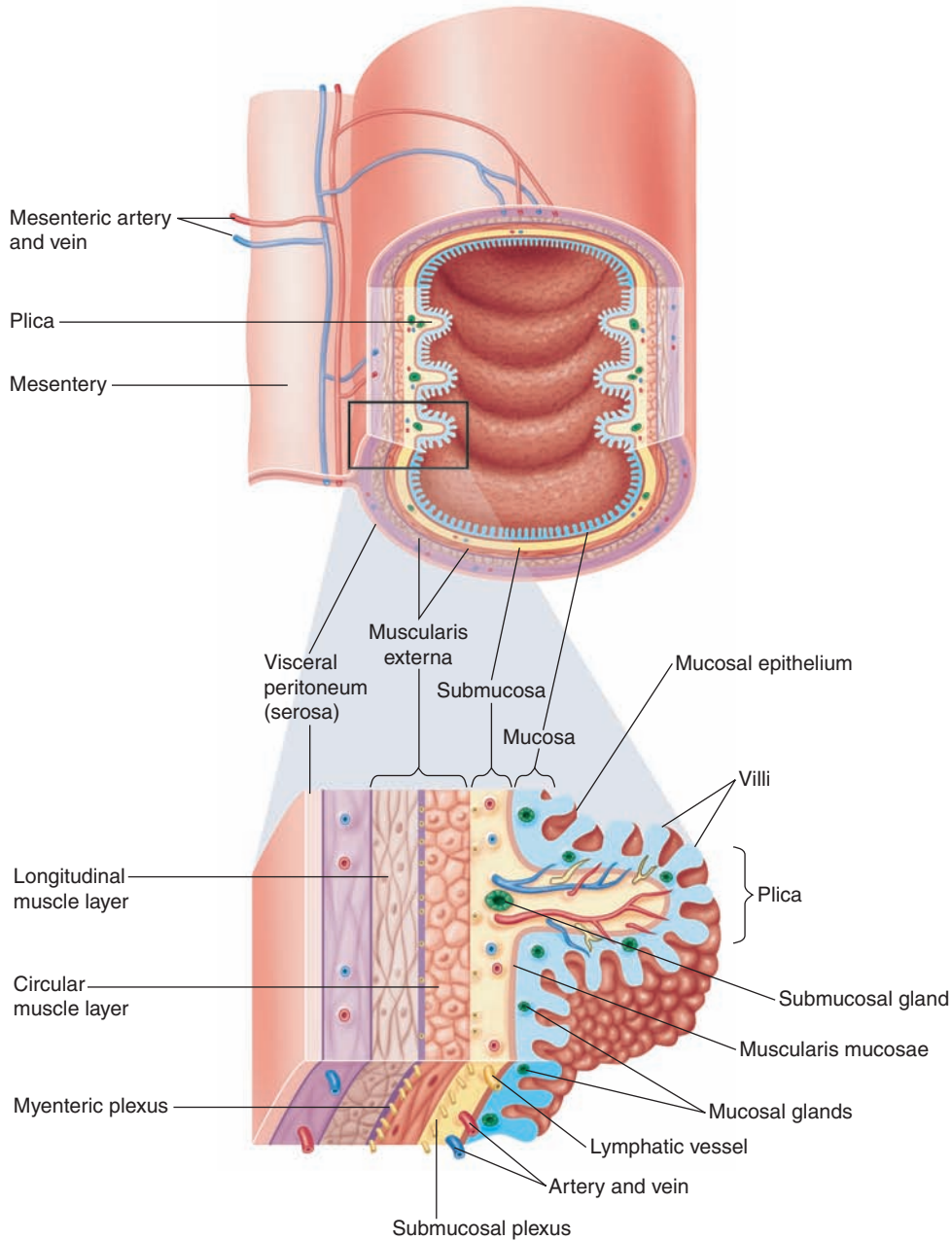


Figure 9-5 ► Mucosal surface of the small intestine.

of abnormalities in the esophagus, stomach, small intestine, and large intestine. These imaging techniques and endoscopy have many applications and will be discussed throughout this chapter.

Diseases of the Mouth

Complete coverage of diseases of the mouth is beyond the scope of this book. This chapter focuses instead on the major oral inflammatory

diseases and neoplasms. Diseases of the mouth can adversely affect the ability to taste, chew, moisten, and swallow food.

Oral Inflammation and Infection

Oral inflammation, or **stomatitis**, is the inflammation of oral tissue. Depending on the cause, stomatitis may appear as patches, ulcers, redness, bleeding, or necrosis. The prevalence of stomatitis is unknown. It occurs mostly among those with risk factors such as immune deficiency and long-term antibiotic use.

Stomatitis is usually caused by viruses. However, stomatitis may also be caused by bacteria and fungi, or it may be a sign of a systemic infection. Streptococci are a common cause of oral and throat bacterial infections, resulting in red, swollen mucosa. Bacteria also cause canker sores, small circular lesions with a red border. These painful lesions heal without scars after a week. *Neisseria gonorrhoeae*, the cause of the sexually transmitted disease gonorrhea, causes painful ulcerations in the mouth and throat. The sexually transmitted bacterium *Treponema pallidum* causes syphilis, which causes oral chancres (small sores associated with the onset of syphilis) and ulcerations. These bacterial infections are treated with antibiotics.

Herpes simplex is a common cause of oral virus infections. Transmitted by genital–oral contact, herpes simplex type 2 causes vesicles that rupture to form ulcers. These lesions can appear inside and outside the mouth. Herpes simplex type 1 can be transmitted by oral–oral contact through saliva, and it can be transmitted from mouth to genitals. Pain from herpes lesions makes eating, drinking, and swallowing difficult. The symptoms typically subside within 2 weeks when the viruses move from the area of the lesion to nerve tissue known as ganglia. The infection can be reactivated following stressful events or suppression of immune function. Treatment is aimed at reducing inflammation and pain with systemic anti-inflammatory and analgesic medications or topical anesthetics.

The fungus *Candida albicans* is normally present in the mouth in low levels but can grow excessively in newborns or those with immune deficiencies or following long courses of antibiotic or corticosteroid treatment. Called candidiasis or thrush, the fungal infection forms painless white

patches that resemble cheese curds. Removing the white patches leaves a raw, damaged mucosal surface. Candidiasis of the esophagus causes throat pain and difficulty swallowing. Antibiotics and antiviral medications are not effective treatments for fungal infections. Oral candidiasis is treated with oral antifungal agents.

Cancer of the Mouth

Oral cancer is a malignant tumor originating within the oral tissues, most often a squamous cell carcinoma. Mouth and throat cancer ranks 11th among the leading causes of cancer death worldwide. Most of these cancers appear on the floor of the mouth, tongue, and lower lip. An aggressive form of the cancer occurs on the upper lip. While the causes remain unknown, it is clear that tobacco, smokeless tobacco, and alcohol use are major risk factors, and it appears that use of alcohol and tobacco in combination increases the risk. Treatment for lip and tongue cancer includes surgical removal. Radiation therapy may be used to treat local cancers on the floor of the mouth. This cancer cannot be prevented, but people can eliminate known risk factors such as smoking and alcohol use.

Diseases of the Esophagus

The function of the esophagus is the controlled passage of food to the stomach. Esophageal disease manifests itself as **dysphagia**, difficult or painful swallowing.

Cancer of the Esophagus

Cancer of the esophagus is a malignant tumor that arises within its tissues. The disease ranks sixth among leading causes of cancer death worldwide. Cancer of the esophagus occurs most commonly in men over age 60 and is nearly always fatal. Like mouth cancer, tobacco and alcohol use are major risk factors.

The cancer narrows the esophageal lumen, causing the principal symptom of dysphagia. The obstruction causes vomiting, a bad taste in the mouth, and bad breath. Esophageal cancer is accompanied by weight loss because of the inability to eat. Diagnosis requires CT or endoscopy. The cancer frequently metastasizes early into adjacent

organs, usually the lungs and liver, and to remote sites through the lymph vessels. Because of early metastasis, the prognosis for esophageal cancer is poor. Esophageal cancer cannot be prevented, but its risk factors can be avoided.

Esophageal Varices

Varicose (enlarged) veins that develop in the esophagus are called **esophageal varices**. The prevalence is unknown, but it affects mainly those who abuse alcohol and those with cirrhosis of the liver.

Cirrhosis of the liver is the chief cause of esophageal varices. The destruction and scarring of tissue associated with cirrhosis impairs blood flow through the liver, which elevates pressure in the veins of the abdomen and elsewhere, including the esophagus. The increased venous pressure causes the esophageal veins to dilate and become knotty. The most serious danger in esophageal varices is hemorrhage. Bleeding esophageal varices require emergency treatment.

Diagnosis requires endoscopy, specifically esophago-gastro-duodenoscopy (EGD), in which an endoscope, a tube with a camera, is inserted to look at the esophagus, stomach, and duodenum. Medical and surgical treatment attempts to reduce bleeding from the varices, but the prognosis is poor for bleeding varices. Esophageal varices cannot be prevented, but risk factors such as alcohol use and smoking can be avoided.

Esophagitis and GERD

Esophagitis is inflammation of the lining of the esophagus. The prevalence is unknown but is related to risk factors such as old age, obesity, and pregnancy.

Esophagitis causes burning chest pains, “heartburn,” which can resemble the pain of heart disease. The pain may follow eating or drinking, and some vomiting of blood may occur. The most common trigger of esophagitis is a **reflux**, a backflow of the acid contents of the stomach. The condition is known as **gastroesophageal reflux disease (GERD)**. GERD may be caused by an incompetent **cardiac sphincter**, which normally prevents stomach contents from ascending the esophagus. Other causes include hiatal hernia and medications that compromise the

sphincter or induce excess acid secretion. The incidence of GERD increases with age, which suggests that age-related changes occur in the sphincter. Whatever the cause, regurgitated stomach acid irritates the lining of the esophagus and stimulates an inflammatory response.

Diagnosis is based on history, signs, and symptoms as well as barium fluoroscopy, measure of esophageal pH, or EGD. Treatment includes a nonirritating diet, antacids, and acid-reducing medications. Painful symptoms frequently occur at night while the body rests horizontal and relaxed; thus patients are advised to sleep with the head elevated and to avoid eating 2–3 hours before sleeping. Prevention of symptoms requires taking frequent, small meals and avoiding alcohol.

Hiatal Hernia

A hernia is the protrusion of part of an organ through a muscular wall or body opening. A **hiatal hernia** is the protrusion of part of the stomach through the diaphragm at the point where the esophagus joins the stomach. The condition is caused by either a congenital defect in the diaphragm or by increased intra-abdominal pressure associated with obesity. Figure 9–6 ► shows this condition. Indigestion and heartburn may occur after eating; shortness of breath may also occur. Diagnosis is based on a chest x-ray or EGD. The aim of treatment is to reduce symptoms. The most effective treatment is cholinergic drugs, which strengthen the cardiac sphincter and reduce reflux after eating. Patients should avoid irritants such as spicy foods and caffeine, take

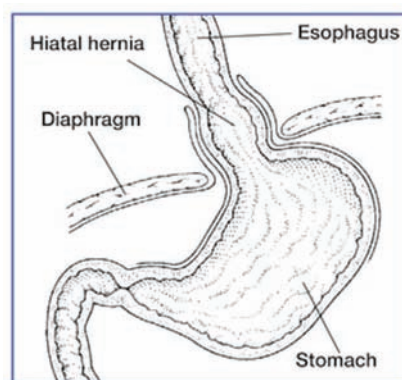


Figure 9–6 ► Hiatal hernia.

frequent small meals, and, if obese, lose weight. Surgery may be required to correct the structural defect, but hiatal hernias tend to recur following surgery. These hernias cannot be prevented.

Diseases of the Stomach

The stomach is well adapted for storing and mixing food with acid and enzymes. Alterations in the stomach lining or malignancies can cause painful and sometimes serious disease.

Gastritis

Acute **gastritis** is an inflammation of the lining of the stomach frequently accompanied by vomiting of blood. Acute gastritis is caused by irritants such as aspirin, excessive coffee, tobacco, alcohol, or infection. Acute alcoholism is a major cause of hemorrhagic gastritis. Chronic alcohol use stimulates acid secretion, which irritates the mucosa. EGD with biopsy (examination of a tissue sample) is extremely valuable in diagnosing this disease. A camera may be attached to the gastroscope to photograph the entire inner lining of the stomach. Treatment includes avoiding known irritants and treating infections. Treatment includes medicines that block gastric secretion. If bleeding occurs, surgery may be required.

Chronic Atrophic Gastritis

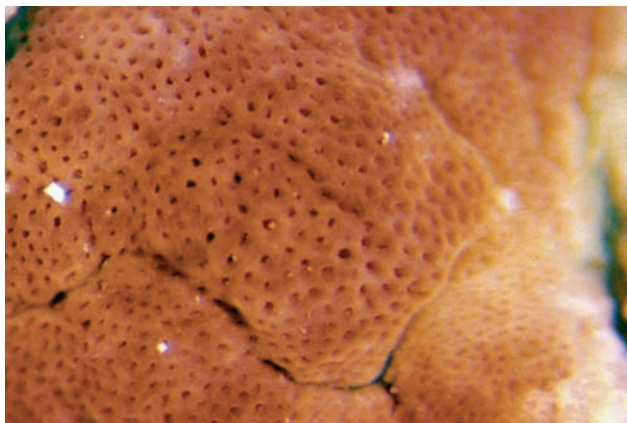
Chronic atrophic gastritis is a degenerative condition in which the stomach lining does not secrete intrinsic factor and hydrochloric acid. Intrinsic factor is required for absorption of vitamin B₁₂, and hydrochloric acid aids protein digestion. Chronic atrophic gastritis may be caused by stomach cancer, chronic alcoholism, or chronic exposure to certain irritants such as alcohol, aspirin, and certain foods. The term **atrophic** (wasting) suggests that little can be done to treat this disease. No prevention is possible, but underlying diseases or causes should be eliminated.

Peptic Ulcers

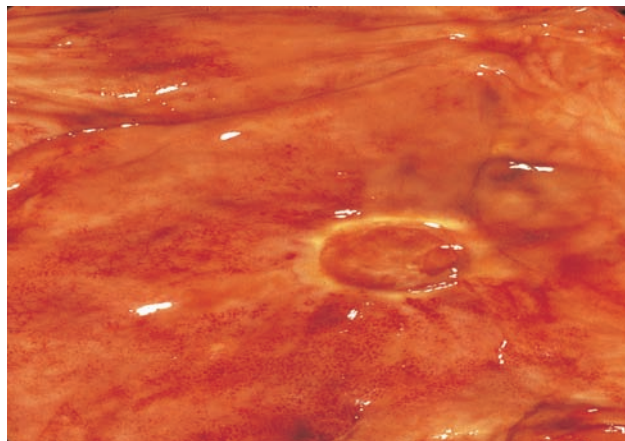
Ulcers are lesions of any body surface where necrotic (dead) tissue forms as a result of inflammation and is sloughed off, leaving a hole. Ulcers of the stomach and small intestine are termed **peptic ulcers**. Types of peptic ulcers are ulcers of the stomach, called **gastric ulcers**, and those of the small intestine are **duodenal ulcers**. Approximately 80% of peptic ulcers are duodenal ulcers, which occur most frequently in men between ages 20 and 50. Figure 9-7 ► shows common sites of peptic ulcers.

SIDE by SIDE

Gastric Ulcer



► Normal mucosa showing openings of gastric glands.
(© C. Abrahams, MD/Custom Medical Stock Photo)



► Superficial gastric ulcer in the stomach lining.

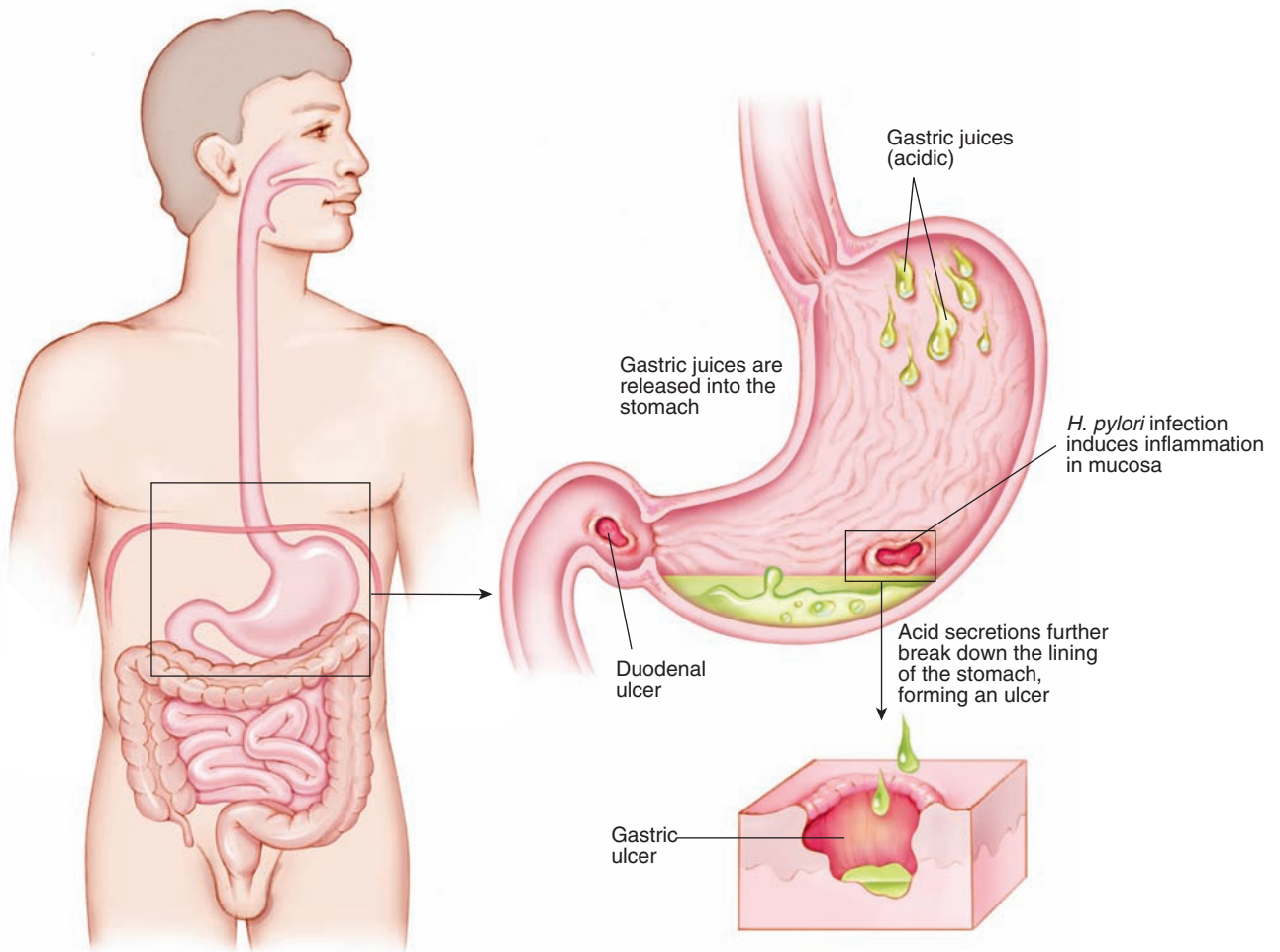


Figure 9-7 ▶ Peptic ulcer disease (PUD).

Peptic ulcers have three main causes: infection with *Helicobacter pylori*, use of nonsteroidal anti-inflammatory drugs, and an inherited disorder of excessive acid secretion. Because hydrochloric acid secretion is under nerve and hormonal control, stressful situations can trigger or exacerbate ulcers. Gastric contents contribute to ulcer formation in all cases. The ulcers are caused, in part, by pepsin, a proteolytic enzyme secreted by the stomach. Hydrochloric acid of the stomach, intestinal juice, and bile also irritate the gastric mucosa. Irritated and inflamed mucous membrane may become necrotic, leaving a hole.

Heartburn and indigestion are frequently the first signs of an ulcer. The ulcer pain is caused by the action of hydrochloric acid on the exposed surface of the lesion. The muscular contractions of peristalsis also intensify the pain. Symptoms of

gastric ulcer include nausea, vomiting, abdominal pain, and, occasionally, massive gastrointestinal bleeding.

A potential complication of an ulcer is hemorrhage; severe hemorrhage may lead to shock. It is possible for a large artery at the base of the ulcer to rupture as the lesion erodes deeper into underlying tissues. Bleeding from the ulcer may appear as **hematemesis** or bloody vomitus, or the blood may appear in stools, where it gives the stools a dark, tarry appearance, referred to as **melena**. A serious ulcer complication is **perforation**. If an ulcer perforates—that is, breaks through the intestinal or gastric wall—there is sudden and intense abdominal pain. **Peritonitis**, inflammation of the lining of the abdominal cavity, usually results when the digestive contents enter the cavity, because this material contains

numerous bacteria. Surgical repair of the perforation is required immediately. Obstruction of the gastrointestinal tract can result from an ulcer and the scar tissue surrounding it. Obstruction occurs most frequently in a narrow area of the stomach near the pyloric sphincter. Ulcer pain can cause the sphincter to go into spasm, also resulting in obstruction.

Diagnosis is based on tests for *H. pylori*, endoscopy, an x-ray, detection of blood in stools, blood tests to determine elevated levels of white blood cells, and gastric content analysis. The main objectives of treatment for peptic ulcer disease are to promote healing, prevent complications and recurrences, and provide pain relief. Acid reducers are more effective for peptic ulcers than are antacids and mucosal barriers. However, antibiotic therapy in combination with acid reducers is required to eradicate *H. pylori* and to reduce the rate of ulcer relapse. If the ulcer is stress or tension related, certain changes in lifestyle or approach to stress might be beneficial to prevent the development of symptoms.

Gastroenteritis and Food Poisoning

Gastroenteritis is an inflammation of the stomach and intestines. Symptoms include anorexia, nausea, vomiting, and diarrhea. The onset may be abrupt, with rapid loss of fluid and electrolytes. Possible causes are bacterial or viral infection, chemical toxins, lactose intolerance, or other food allergy, although the actual cause is not always clear. Treatment replaces fluid and nutritional requirements, including the lost salts. Antispasmodic medications can control the vomiting and diarrhea.

Food contaminated with human or animal feces may carry microorganisms that cause gastroenteritis and food poisoning. *Escherichia coli* is a normal inhabitant of human or animal intestines. Certain strains may cause disease, such as traveler's diarrhea, or more serious diseases, such as hemolytic uremic syndrome, in which toxins cause potentially fatal shutdown of the kidneys. To prevent infection, cook meat thoroughly and practice good hygiene in the kitchen.

One of the common forms of food poisoning is caused by the bacterium *Salmonella*. These bacteria invade the intestinal mucosa and cause sudden, colicky abdominal pain, nausea,

vomiting, and sometimes bloody diarrhea and fever that begins approximately 6–48 hours after eating contaminated food and lasts up to 2 weeks. A stool culture can identify the bacteria. *Salmonella* food poisoning (salmonellosis) is associated with contaminated eggs and poultry, but most any food may harbor the bacteria. Treatment usually consists of replenishing water, electrolytes, and nutrients. Older adults, young children, and immunocompromised people are at risk of developing serious infection, and they may require more intervention, including a short course of antibiotics and antidiarrheal medications.

Vomiting

Vomiting is a sign, not a disease. Vomiting is a protective response to the presence of an irritant, infection, distention, or a blockage. These stimulate sensory nerve fibers, and the message is conveyed to the vomiting center in the medulla of the brain. Motor impulses then stimulate the diaphragm and abdominal muscles, which squeeze the stomach. The sphincter at the base of the esophagus opens and the gastric contents are **regurgitated**. A feeling of nausea often precedes vomiting. The cause of the nausea may be factors other than a gastric or intestinal irritant. Motion sickness produces this effect. A very unpleasant smell or sight can cause nausea with possible subsequent vomiting.

Cancer of the Stomach

Cancer of the stomach is a malignant tumor originating from stomach tissues. The incidence of stomach cancer in the United States has dropped dramatically over the past 30 years. It has become an uncommon disease and accounts for less than 1% of all cancers. Stomach cancer is the ninth leading cause of cancer death in men, and is more prevalent among men over age 40 than among women. *H. pylori* infection appears to increase the risk for stomach cancer, probably through its damaging effects on the mucosal cells.

The stomach cancer may be a large mass projecting into the lumen of the stomach, or it may invade the stomach wall, causing it to thicken. As the tumor grows, the lumen narrows to the

Promote Your Health

The Benefits of Fiber

Most Americans do not get nearly enough fiber in their diet. Soluble fiber is partially digested, enters the intestines, and binds some cholesterol, thus removing some from the intestine. Insoluble fiber cannot be digested and remains in the intestine, adding bulk and helping move waste material out of the intestine. Soluble fiber is found in oats, oatmeal, oat bran, nuts, fruits, and dry beans and peas. Insoluble fiber

is in whole wheat bread and grains such as barley, brown rice, bulgur, whole-grain cereals, wheat bran, vegetables, and fruits. A person requiring 2,000 calories per day should eat about 28 grams of fiber per day. High-fiber diets reduce the risk for colorectal cancer, diabetes, obesity, and heart disease.

point of obstruction. The remainder of the stomach becomes extremely dilated due to the blockage, and pain results from pressure on nerve endings. Infection frequently accompanies cancer, which causes additional pain. Because pain is not an early sign, carcinoma of the stomach may be very advanced before it is detected. It may even have spread to the liver and surrounding organs through the lymph and blood vessels. Early symptoms are vague and include loss of appetite, heartburn, and general stomach distress. Blood may be vomited or appear in the feces. Pernicious anemia generally accompanies cancer of the stomach because the gastric mucosa fails to secrete intrinsic factor. The etiology of this malignancy is not known, but current research suggests an association with the consumption of preserved, salted, cured foods and a diet low in fresh fruits and vegetables.

Diagnosis requires EGD and gastric analysis by means of a stomach tube to determine the absence of hydrochloric acid, or **achlorhydria**. Biopsy of any lesions seen through the gastroscop is an essential diagnostic procedure for carcinoma of the stomach. Treatment includes surgery and chemotherapy. Good prognosis for this disease depends on early detection and treatment. While it cannot be prevented, the risk factors for stomach cancer can be avoided.

Diseases of the Intestines

The small intestine is the site of most of the digestion and absorption that occurs in the digestive tract, while the large intestine absorbs remaining water and stores and concentrates

the feces. Diseases in these areas may manifest themselves as diarrhea, constipation, changes in stool characteristics, or secondary diseases that arise as a result of poor nutrition.

Appendicitis

Appendicitis is an acute and painful inflammation of the appendix. Appendicitis can occur at any age, but it is more common among males before puberty to age 25. The wormlike shape of the appendix and its location on the cecum make it a trap for fecal material, which contains bacteria, particularly *Escherichia coli*. Figure 9-8 ► illustrates this potential site of infection. Obstruction with fecal material and infections cause the appendix to become swollen, red, and covered with an inflammatory exudate. Because the swelling interferes with circulation to the appendix, it is possible for **gangrene** to develop. The appendix then becomes green and black. The wall of the appendix can become thin and rupture, spilling fecal material into the peritoneal cavity, causing **peritonitis**. Before antibiotic treatment, peritonitis was almost always fatal.

Diagnosis depends on physical exam. The pain of appendicitis varies, often beginning in the middle of the abdomen and shifting to the lower right quadrant. Patients may walk or lie bending over, and draw the right leg up to the abdomen to seek pain relief. Other diagnostic signs and symptoms include nausea, vomiting, fever of between 99°F and 102°F, and elevated white blood cell count. Untreated appendicitis is fatal, and surgery must be performed before rupture occurs.

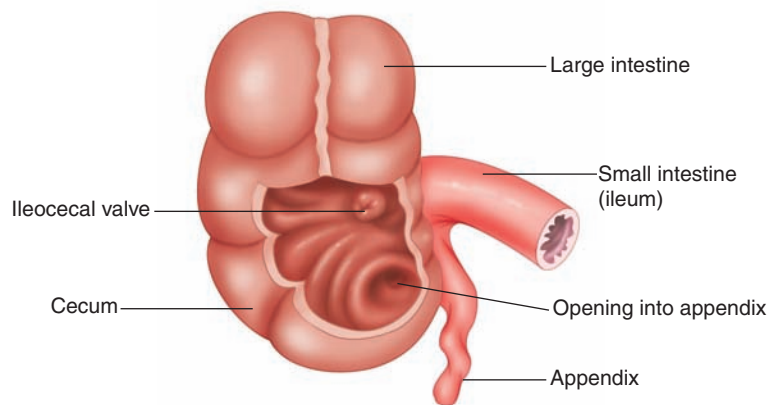


Figure 9–8 ► Appendix attached to cecum into which the small intestine empties.

Malabsorption Syndrome

The inability to absorb fat or some other substance from the small intestine is known as **malabsorption syndrome**. The prevalence of malabsorption syndrome is not known because it is a syndrome that accompanies several other types of diseases and disorders. For example, a diseased pancreas or blocked pancreatic duct deprives the small intestine of **lipase**. In the absence of lipase, fat is not digested and cannot be absorbed. Also, liver disease or a blocked bile duct leads to inadequate bile secretion, which prevents lipid digestion and causes malabsorption.

Signs and symptoms of malnutrition occur, including lack of energy and inability to maintain weight. Because fat cannot be absorbed from the intestine, it passes into the feces, and the result is unformed, fatty, pale stools with a foul odor. The fat content causes the stools to float.

One of the complications of malabsorption syndrome is bleeding. Vitamin K, a fat-soluble vitamin that is essential to the blood-clotting mechanism, cannot be absorbed. Treatment for malabsorption syndrome depends on its cause, and diet is carefully controlled. Supplements are administered, such as the fat-soluble vitamins A, D, E, and K.

Celiac Disease

Celiac disease is characterized by poor nutrient absorption. Celiac disease affects about 2 million Americans, or 1 in 133 people. Celiac disease

Prevention PLUS!

Bacteria, Coolers, and Food Poisoning

Refrigeration and freezing do not kill bacteria. The cold temperature inhibits their growth, which can resume at warmer temperatures. Under optimum conditions, bacteria grow rapidly and double their numbers every 30 minutes. A contaminated potato salad may be safe to eat right out of the refrigerator, but it may become the source of a serious infection if brought to a picnic and left to stand at air temperature for a couple of hours. In other words, it is a good idea to keep the potato salad in the cooler while you are playing softball at your next picnic!

Think Critically

1. Why doesn't cold temperature kill bacteria?
2. If bacteria can grow rapidly at warmer temperatures, why does cooking kill bacteria?

seems to be genetic, may involve immune dysfunction, affects twice as many females as males, and is more common among whites of European ancestry. It is caused by intolerance to gluten, a protein component of wheat.

Signs and symptoms include recurrent diarrhea, gas, abdominal cramps, and systemic signs of malnutrition due to low caloric intake and poor absorption of vitamins. Onset is usually by age 1, when wheat products are first consumed. Celiac disease is diagnosed by the signs and symptoms as well as by biopsy of the small intestine, which reveals atrophy and flattening of intestinal villi. Treatment involves elimination of gluten from

the diet, fluid replacement, and vitamin supplements. Celiac disease cannot be prevented.

Diverticulitis

Diverticula are little pouches or sacs formed when the mucosal lining pushes through the underlying muscle layer of the intestinal wall. This condition is called **diverticulosis** and may cause no harm in itself. **Diverticulitis** is an inflammation of the diverticula. Diverticulitis occurs when the sacs become impacted with fecal material and bacteria. Diverticular disease is most prevalent in Western industrialized nations where fiber consumption is lowest. About 50% of older adults develop diverticulosis. Risk is associated with age, diet low in fiber, and family history. Diverticulitis causes low, cramping pain, usually on the left side of the abdomen. As inflammation spreads, the lumen of the intestine narrows, an obstruction can develop, and abscesses frequently form. Diverticular disease is diagnosed with CT and endoscopy. Antibiotic therapy, together with a controlled diet, is usually effective. Figure 9-9 ► shows an example of diverticulitis.

Regional Enteritis (Crohn's Disease)

Regional enteritis (Crohn's disease) is an inflammatory disease of the intestine that most frequently affects the upper colon and sometimes the distal end of the ileum. Crohn's disease usually affects white adults ages 20–40, and is two

to three times more common among Ashkenazi Jews. Risk factors are unknown but may involve family history or autoimmune disease. Possible causes include allergies, immune disorders, or stress, but the exact cause remains unknown.

Signs and symptoms are related to the inflammation. As inflammation progresses, the intestinal walls become thick and rigid. With thickening, the lumen narrows and develops a chronic obstruction. The pain of regional enteritis resembles that of appendicitis, occurring in the lower right quadrant of the abdomen, where a tender mass may be felt. Diarrhea, constipation, and **melen**a are common. Severe diarrhea can cause an electrolyte imbalance because of the large amount of water and salt lost in the stools. **Anorexia**, nausea, and vomiting lead to weight loss. Periods of exacerbation, remission, and relapse are common; during flare-ups, the inflammation can also manifest as rheumatoid arthritis. Severe cases entail a risk for hemorrhage or perforation.

Crohn's disease is diagnosed by CT and endoscopy, an elevated level of white blood cells, and low levels of potassium, calcium, and magnesium. Biopsy confirms the diagnosis. Crohn's disease is usually treated with anti-inflammatory medications and with immunosuppressive agents. Surgery is performed to correct complications such as obstruction, perforation, or massive hemorrhage. Ileostomy is necessary if the large intestine has been severely damaged. Crohn's disease cannot be prevented, but outbreaks can be controlled.

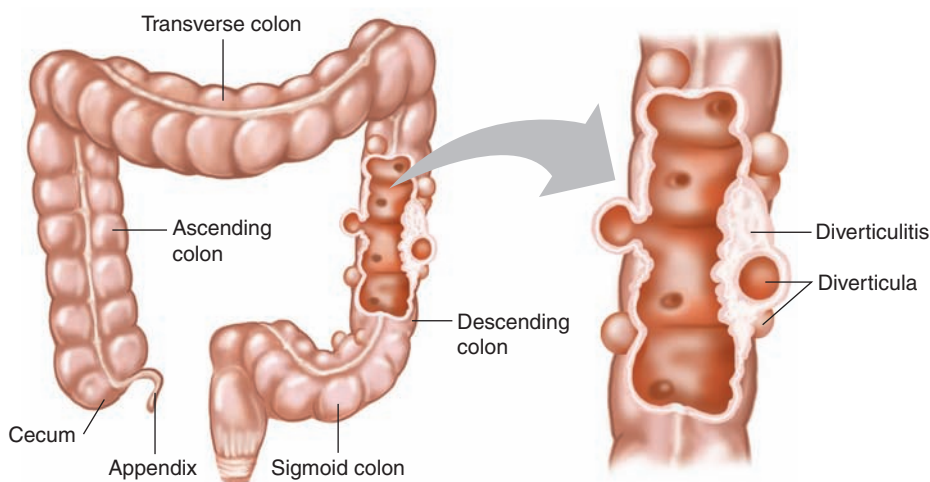


Figure 9-9 ► Diverticulitis.

Chronic Ulcerative Colitis

Chronic ulcerative colitis is a serious inflammation of the colon characterized by extensive ulceration of the colon and rectum. The prevalence of ulcerative colitis remains unknown but may be as much as 100 per 100,000. Ulcerative colitis occurs primarily in young adults, especially women, and usually begins between ages 15 and 20. No known causes have been found; however, ulcerative colitis may be related to autoimmunity, *E. coli* infection, stress, or hypersensitivity to certain foods.

Typical symptoms include diarrhea with pus, blood, and mucus in the stools and cramplike pain in the lower abdomen. Periods of remission and exacerbation are common in ulcerative colitis. Anemia often accompanies ulcerative colitis because of the chronic blood loss through the rectum. Increased risk for colon malignancy is associated with longstanding ulcerative colitis.

Diagnosis is based on colonoscopy and CT in which the colon has a characteristic appearance; the normal pouchlike markings of the colon are lacking, and the colon appears straight and rigid (a “**pipestem colon**”).

Treatment is aimed at reducing symptoms, replacing nutrients, stopping blood loss, and preventing complications. The symptoms may be alleviated by reducing stress, eliminating foods found to trigger symptoms, and taking adrenal corticosteroids such as prednisone and hydrocortisone to control autoimmunity. If these treatments are not effective, surgery and colostomy may be necessary. A **colostomy** is an artificial opening in the abdominal wall with a segment of the large intestine attached. Fecal waste is evacuated through this opening and collected in a bag. A colostomy may be temporary or permanent depending on the nature of the colon surgery. Although it cannot be prevented, the symptoms of chronic ulcerative colitis can be managed.

Cancer of the Colon and Rectum

Cancer of the colon and rectum is the fourth leading cause of death from cancer in the United States. The incidence in men and women is roughly equal. Longstanding ulcerative colitis and familial polyposis of the colon each increase

the risk for cancer of the colon. **Familial polyposis** is a hereditary disease in which numerous polyps develop in the intestinal tract. The polyps usually give no symptoms unless a malignancy develops. Another factor associated with risk for colon cancer is a diet high in red meat and low in dietary fiber.

The symptoms vary according to the site of the malignancy. A change in bowel habits, diarrhea, or constipation is symptomatic. As the tumor grows, there may be abdominal discomfort and pressure. Blood often appears in the stools, and continuous blood loss from the malignant tumor causes anemia. The mass can partially or completely obstruct the lumen of the colon. As the tumor invades underlying tissue, the cancer cells spread through the lymph vessels and veins.

Colorectal cancer is diagnosed with a digital rectal examination and CT. Colorectal cancer grows slowly, tends to remain localized, and is thus potentially curable with early diagnosis. As in all cancers, early detection and treatment are essential to prevent its spread. Most malignancies of the large intestine are in the rectum or the sigmoid colon, which makes their detection and removal easier than malignant tumors in other areas of the digestive tract. Chemotherapy is used when the tumor has metastasized or if residual masses remain inoperable. If sections of the colon are removed, a colostomy may be necessary.

Intestinal Obstructions

An obstruction can occur anywhere along the intestinal tract, preventing contents within the tract from moving forward. **Obstructions** are classed as **organic** when there is some material blockage. Other obstructions are classified as **paralytic** or **functional** when there is a decrease in **peristalsis**, preventing the propulsion of intestinal contents. Obstructions take several forms:

- Tumors: physically obstruct intestine
- Hiatal and inguinal hernias: intestine pinches as it protrudes through muscle of body wall
- **Volvulus**: intestine twists on itself (Figure 9–10 ►)

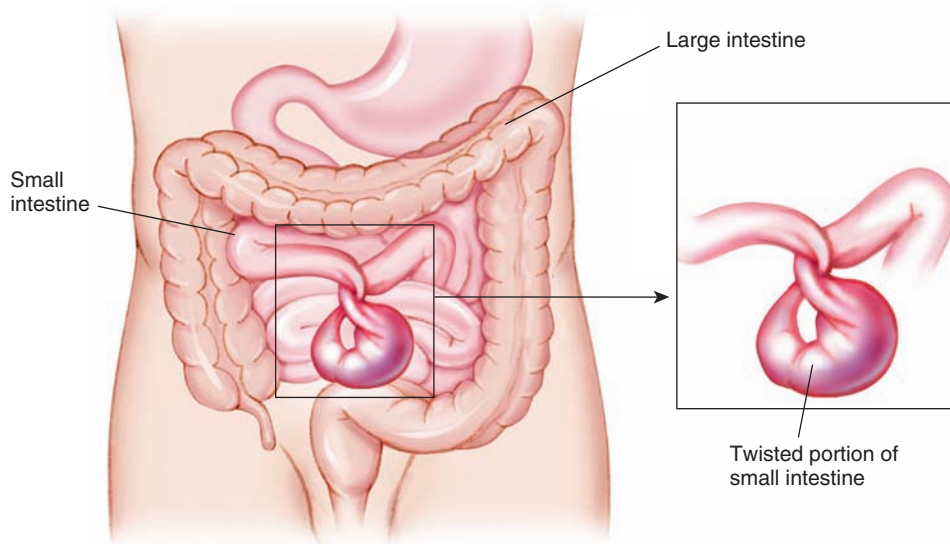


Figure 9-10 ► Volvulus.

- **Adhesions:** linking of two surfaces by fibrous scars; occurs following surgery or inflammation
- **Intussusception:** a segment of intestine telescopes into the part forward to it

Figure 9-11 ► shows various types of organic obstructions. An acute organic obstruction causes severe pain. The abdomen becomes distended and vomiting occurs. There is complete constipation; not even gas, or **flatus**, is passed. Sometimes the obstruction can be relieved by means of a suction tube, but frequently surgery is required. If the obstruction is a strangulated hernia, a protrusion of intestine through the abdominal wall, surgery is required because the strangulated segment can become gangrenous.

A paralytic obstruction can result from peritonitis. If a loop of small intestine is surrounded by pus from the infection, the smooth muscle of the intestinal wall cannot contract. Sphincters can go into spasm and fail to open as a result of intense pain. These obstructions cannot be prevented.

Hemorrhoids

Hemorrhoids are varicose veins in the lining of the rectum near the anus. Hemorrhoids may be internal or external. A physician can observe internal

hemorrhoids with a **proctoscope**, a hollow tube with a lighted end. External hemorrhoids can be seen with a handheld mirror. Causes of hemorrhoids include heredity, poor dietary habits, inadequate fiber, overuse of laxatives, and lack of exercise. Straining to have a bowel movement can cause bleeding or cause the hemorrhoid to **prolapse**, or come through the anal opening. Hemorrhoids frequently develop during pregnancy because of pressure from an enlarged uterus. Treatment includes adding fiber and water to the diet and stool softeners to reduce straining and subsequent inflammation. Medicated suppositories and anorectal creams relieve pain and reduce inflammation.

Spastic Colon (Irritable Bowel Syndrome)

Irritable bowel syndrome or **spastic colon** is relatively common, occurring in 20% of American adults and affecting more women than men. Irritable bowel is marked by diarrhea, constipation, abdominal pain, and gas. The difference between a spastic or **irritable colon** and the diseases already discussed is that the spastic colon has no lesion, no tumor, and no ulceration. It is a functional disorder of motility, the movement of the colon. The pain is probably caused by muscle spasms in the wall of the intestine.

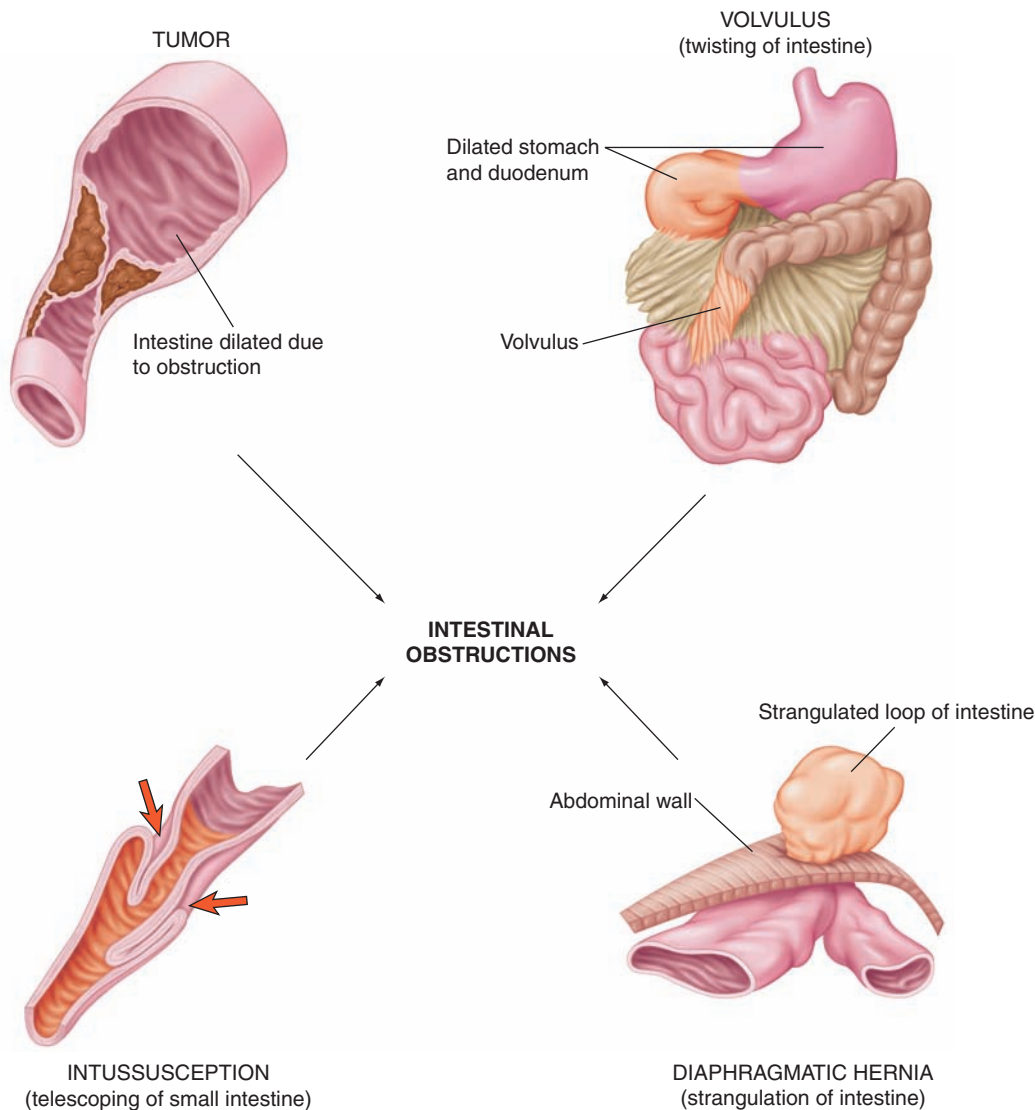


Figure 9–11 ► Organic obstructions of the intestinal tract.

The risk factors may include abuse of laxatives and consumption of certain foods and beverages, particularly caffeine, alcohol, spicy foods, fatty foods, and concentrated orange juice that can irritate the bowel. Foods such as beans and cabbage, which contain carbohydrates fermented by colon bacteria, promote gas production and should be avoided. Laxatives should be avoided as well. Adding fiber to the diet helps prevent constipation. Emotional stress has an adverse effect on the digestive system because the nerves of the autonomic nervous system affect digestion. If stressful situations can be alleviated, the colon will function more normally. Tension-relieving activities,

sports, hobbies, or regular exercise may help. Although it cannot be prevented, the risk factors for developing spastic colon can be avoided.

Dysentery

Dysentery is an infectious disease with acute inflammation of the colon. Dysentery is relatively uncommon in the United States, although outbreaks occur when food or water sanitation break down. Worldwide, dysentery is the leading cause of death from infectious disease in young children. Risk factors include poor sanitation, being under age 6 and over age 65, and having

Prevention PLUS!

Cancer Prevention through Detection

Early detection of colorectal cancer is the key to survival. Death rates are low for patients whose colorectal cancer is detected at an early localized stage; about 9% die within 5 years. Death rates are much higher, however, when the diagnosis occurs at an advanced stage; about 92% die within 5 years. Screening remains underused even though its benefits seem clear. Regular screening should be done for adults age 50 years and over. This includes an annual fecal occult blood test, a flexible sigmoidoscopy every 5 years, and a colonoscopy every 10 years. These tests can identify precancerous polyps that can be removed, or they can detect cancer in the early localized stage, which can be treated before the cancer has a chance to spread.

Think Critically

1. Why wait until age 50 to screen?
2. Why would someone be screened at a younger age?

immune deficiency. Bacteria, parasitic worms, and other microorganisms can cause dysentery. The protozoan *Entamoeba histolytica*, which is transmitted in feces-contaminated food and water, causes amebiasis, also called amoebic dysentery. Amoebic dysentery is uncommon in the United States and is usually found among immigrants arriving from countries with poor water quality and sanitary procedures. American travelers acquire amoebic dysentery when drinking contaminated water abroad.

The major signs and symptoms of dysentery include diarrhea containing pus, blood, and mucus, accompanied by severe abdominal pain. *E. histolytica* invade the wall of the colon and cause numerous ulcerations, which account for the pus and blood in the stools. Bacillary dysentery is caused by various species of gram-negative bacteria in the genus *Shigella*. Antibiotics can be effective for bacillary dysentery, and amebicides are used for amoebic dysentery. Dysentery can be prevented by maintaining sanitary food and water.

Diarrhea

Diarrhea is the frequent passage of unformed, watery stools that results when the contents of the small intestine are rushed through the large intestine. Diarrhea is a sign, not a disease. In an episode of diarrhea, the large intestine cannot

Healthy Aging

Diet Makes a Difference

The Centers for Disease Control and Prevention notes that only about 27% of people age 65 and older eat five or more servings of fresh fruit and vegetables each day. A diet rich in fruits and vegetables reduces the risk of many diseases, including colorectal cancer, diabetes, hypertension, and coronary artery disease. If you are younger, consider taking up healthful eating habits. Also consider assisting older adults you know with making good food choices and help them get the foods they need.

reabsorb water from feces because peristalsis in the intestine is intensified. Intestinal infections and food poisoning increase intestinal motility or impair water absorption by mucosal cells. Anxiety and stress can trigger this increased motility of the large intestine.

Constipation

Constipation is the inability to eliminate feces from the colon and results when feces become hard and dry. Poor habits of elimination, dehydration, and low-fiber diets may cause constipation. Defecation should be allowed to occur when the defecation reflexes are strong. Otherwise, feces remain in the colon too long, excessive water reabsorption occurs, and the feces become dry, making elimination difficult. A diet containing adequate amounts of fiber aids elimination by providing bulk, which stimulates intestinal motility. Fiber is obtained from fresh fruits, vegetables, and cereals.

Diseases Indicated by Stool Characteristics

Microscopic examination of stool may identify the cause of food poisoning, gastroenteritis, or dysentery. Other information can also be obtained from stool samples. Signs of several of the diseases discussed include blood in the stools. Blood appears differently, however, depending on the site of bleeding.

If the blood in the stools is bright red, the bleeding originated from the distal end of the colon,

the rectum. Streaks of red blood can indicate bleeding hemorrhoids. This symptom can also indicate cancer of the rectum. Dark blood may appear in the stools, giving them a dark, tarry appearance, known as **melena**. This blood was altered as it passed through the digestive tract, so it originated from the stomach or duodenum. A bleeding ulcer or cancer of the stomach may be indicated by melena. Certain medications (those containing iron, for instance) can also give this tarry appearance to the stools. Blood may not be apparent to the naked eye, but a chemical test can show its presence. This is referred to as **occult blood**. It can indicate bleeding ulcers or a malignancy in the digestive tract.

If the stools are large and pale, appear greasy, and float on water, they contain fat. This is a symptom of malabsorption syndrome. It may also indicate a diseased liver, gallbladder, or pancreas. Diseases of these organs are discussed next.

Diseases of the Liver

Liver disease manifests itself during inflammation or when chronic damage to liver cells cannot be repaired. When fibrous tissue replaces liver cells, the normal functions of the liver become impaired.

Jaundice

Jaundice, or **icterus**, is a yellow or orange discoloration of the skin, tissues, and the whites of the eyes. Jaundice is frequently associated with liver disease. It is caused by a buildup of bilirubin, a yellow pigment derived from the breakdown of hemoglobin that is normally excreted in bile and urine. Jaundice results from liver disease such as cirrhosis or hepatitis, inflammation of the gallbladder or bile ducts, gallstones, or hemolytic anemia.

Viral Hepatitis

Hepatitis, or inflammation of the liver, is caused by a number of factors, including several viruses. Important causes are hepatitis virus A, hepatitis virus B, hepatitis virus C, and hepatitis virus D. Hepatitis E is uncommon in the United States.

Hepatitis virus A, formerly called *infectious hepatitis*, is the least serious form and can develop as an isolated case or in an epidemic. In the United States, as many as 30,000 people

per year had hepatitis A infection until the hepatitis A vaccine was introduced between 1996 and 1999. Since introduction of the vaccine, the number of cases has dropped dramatically. The incubation period for hepatitis A, the time from exposure to the development of symptoms, is from 2 to 6 weeks. The symptoms include anorexia, nausea, and mild fever. The urine becomes dark in color, and jaundice appears in some cases. On examination, the liver may be found to be enlarged and tender. Contaminated water or food is the usual source of the infection, which spreads under conditions of poor sanitation. The virus is excreted in the stools and urine, infecting soil and water. Hepatitis virus A is usually mild in children; it is sometimes more severe in adults. Prognosis is usually good, with no permanent liver damage resulting. **Immunoglobulin** injections provide temporary protection against hepatitis virus A for people exposed to it. The vaccine now in use has proven to be effective. Exposure to hepatitis A gives lifetime immunity.

Hepatitis virus B, formerly called *serum hepatitis*, is a more serious and common disease, affecting more than 60,000 Americans per year. In fact, 1.25 million Americans are chronically infected with hepatitis B, 25% of whom will die from cirrhosis. The symptoms are similar to those of hepatitis virus A, but develop more slowly. The incubation period is long, lasting from 2 to 6 months. The severity of the disease varies greatly. Those with poor nutritional status, for example, will be more adversely affected. Occasionally, a **fulminating** form of hepatitis virus B develops, and it is fatal. This form has a sudden onset and progresses rapidly. Delirium is followed by coma and death. Hepatitis virus B can be transmitted by donated blood or serum transfusions that contain the virus. It is also transmitted sexually and through contaminated needles or syringes used by drug addicts. Physical condition at the onset of the disease makes a difference in the seriousness of the infection. Blood and plasma are screened for hepatitis, but hospital personnel still must be well informed of the hazards that can lead to acquiring hepatitis. Precautions must be taken by nurses, laboratory technicians, dialysis workers, and blood bank personnel to prevent becoming infected. The hepatitis B vaccine provides immunity, and it should be administered to personnel who handle or come in close contact with blood or other bodily fluids.

Hepatitis C infections have declined in the United States to approximately 26,000 per year, but hepatitis C remains the leading viral cause of chronic liver disease and cirrhosis and is now the most common reason for liver transplants. Because of the very high rates of infection seen in the 1980s, over 4 million Americans are infected today, 3.2 million of whom are chronically infected. The initial symptoms are non-specific and similar to those of hepatitis A or B, but the disease persists for months, even years. About 20% of those infected with hepatitis C develop cirrhosis, and a number of these cases can lead to end-stage liver disease. The virus is transmitted mostly through blood transfusions, although transmission has been traced to intravenous drug use, and epidemiologic studies show a risk associated with sexual contact with someone with hepatitis and with having had more than one sex partner in a year. Treatments include interferon injections and oral ribavirin. Treatment for end-stage cirrhosis may include liver transplant.

Hepatitis D virus is described as a defective virus because it cannot reproduce in a cell unless the cell is also infected with hepatitis B. The resulting disease is more serious and more frequently progresses to chronic liver disease. Rates of hepatitis D are not known because surveillance is not systematically conducted; however, hepatitis D is quite uncommon, although its transmission is known to be similar to that of hepatitis B.

Hepatitis E is very rare in the United States, but worldwide it is the leading cause of epidemics of infectious hepatitis. Major epidemics occur in Africa, Asia, and Mexico, where it is transmitted primarily through fecal-contaminated drinking water. Nearly every case in the United States occurs in travelers to areas where the disease is endemic. No effective treatment or vaccine exists. Fortunately, there is no evidence that hepatitis E progresses to chronic disease.

Cirrhosis of the Liver

Cirrhosis is chronic destruction of liver cells and tissues with a nodular, bumpy regeneration. Cirrhosis is the 12th leading cause of death in the United States, killing about 26,000 people each year. Alcoholic cirrhosis, the most common type of cirrhosis, is described here. This disease

is also called portal, Laennec, or fatty nutritional cirrhosis (an accumulation of fat often develops within the liver). The exact effect of excessive alcohol on the liver is not known, but it may be related to the malnutrition that frequently accompanies chronic alcoholism, or the alcohol itself may be toxic.

The normal liver is composed of a highly organized arrangement of cells, blood vessels, and bile ducts. A cirrhotic liver loses this organization and cannot function. Liver cells die and are replaced by fibrous connective tissue and scar tissue, which has none of the liver cell functions. At first, the liver is generally enlarged due to regeneration but then becomes smaller as the fibrous connective tissue contracts. The surface acquires a nodular appearance, sometimes called a “hobnailed” liver.

The changes of cirrhosis impair blood circulation through the liver. As a result, high pressure builds in vessels of the abdomen and in other areas. The esophageal veins swell, forming esophageal varices. Abdominal organs such as the spleen, pancreas, and stomach also swell. These organs and vessels may hemorrhage, causing hemorrhagic shock. Hemorrhage of varices in the stomach or intestines may cause vomiting of blood, or **hematemesis**.

A characteristic symptom of cirrhosis is distention of the abdomen caused by the accumulation of fluid in the peritoneal cavity. This fluid is called **ascites** and develops as a result of liver failure. The pressure within the obstructed veins forces plasma into the abdominal cavity. This fluid often must be drained.

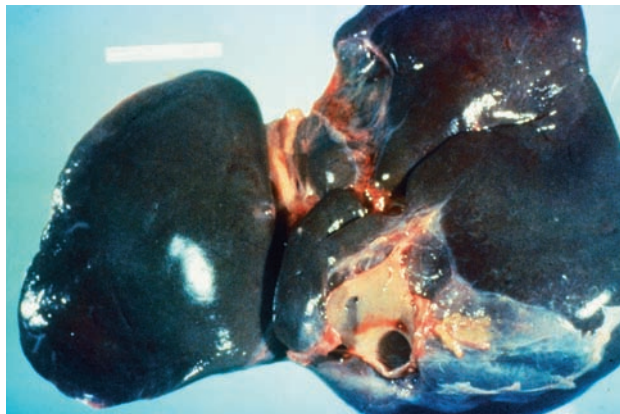
When the liver fails to produce adequate amounts of albumin, an albumin deficiency, **hypoalbuminemia**, develops and fluid leaks out of the blood vessels, causing edema. Because the necrotic cells of the cirrhotic patient fail to produce albumin, ascitic fluid develops, as does edema, particularly in the ankles and legs.

Blockage of the bile ducts also follows the disorganization of the liver. Bile accumulates in the blood, leading to jaundice and, because bile is not secreted into the duodenum, clay-colored stools. The excess of bile, carried by the blood to the kidneys, imparts a dark color to urine.

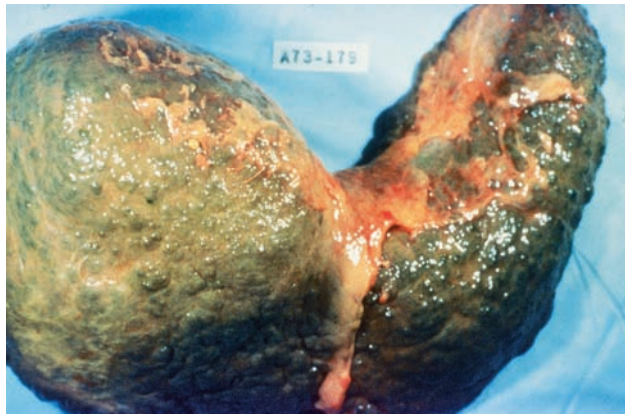
Other signs are related to the fact that the diseased liver cannot perform its usual biochemical activities. Normally, the liver inactivates small amounts of female sex hormones secreted by

SIDE by SIDE

Cirrhosis



► Normal human liver.



► Cirrhosis of the liver from chronic alcoholism.

the adrenal glands in both males and females. Estrogens then have no effect on the male, but the cirrhotic liver does not inactivate estrogens. They accumulate and have a feminizing effect on males. The breasts enlarge, a condition known as **gynecomastia**, and the palms of the hands become red because of the estrogen level. Hair on the chest is lost, and a female-type distribution of hair develops. Atrophy of the testicles can also occur.

The damaged liver cells are unable to carry out their normal function of detoxification, so ammonia and other poisonous substances accumulate

in the blood. Elevated ammonia causes neurologic disorders, including confusion, disorientation, stupor, and a tremor called asterixis or “liver flap.” Elevated ammonia can lead to somnolence (abnormal sleepiness) and **hepatic coma**, a cause of death in cirrhosis.

Although chronic alcoholism is the leading cause of cirrhosis, other diseases can also cause it. Severe chronic hepatitis, chronic inflammation of the bile ducts, and certain drugs and toxins can cause necrosis of the liver cells, which is the first step in the development of cirrhosis.

There is no effective treatment for cirrhosis. Liver damage cannot be reversed, but further damage can be prevented by treating alcoholism or liver infections that are at the root of cirrhosis. Symptoms of cirrhosis may be treated. For example, edema is treated with diuretics and portal hypertension is remedied with beta blockers to reduce blood pressure. Liver transplant is the only way to restore liver function.

Prevention PLUS!

Know Your Viruses

The more you know about how a virus is transmitted, the better prepared you can be to prevent infection. Hepatitis A is transmitted primarily through contaminated food and water. Hepatitis B and C are transmitted through contaminated needles and syringes and by sexual intercourse. Hepatitis B and C are rarely transmitted by transfusions because blood is screened for viruses.

Think Critically

1. Which type of hepatitis can be controlled by practicing good handwashing techniques?
2. Contaminated blood transmits which type of hepatitis?

Cancer of the Liver

Hepatocarcinoma, or cancer of the liver, is a rare primary malignancy of the liver with a high mortality rate. While liver cancer comprises 1% of all cancers in the United States, it accounts for 6% and 2% of cancer deaths in men and women, respectively. Liver cancer is most prevalent in

men over age 60, and the incidence increases with age. Most cancer found in the liver is secondary, a result of metastasis from cancer in other organs, especially the colon, rectum, stomach, pancreas, esophagus, lung, or breast. Primary cancer of the liver is caused chiefly by viral hepatitis and cirrhosis. Other causes of liver cancer may include aflatoxin, a toxin from a mold that grows on peanuts and rice.

The symptoms of hepatocarcinoma vary according to the site of the tumor. If the tumor obstructs the portal vein, ascites develops in the abdominal cavity, as it does in cirrhosis. If the fluid contains blood, a malignancy is indicated. A tumor blocking the bile duct will cause jaundice. General symptoms may include loss of weight and an abdominal mass and pain in the upper right quadrant of the abdomen.

Diagnosis includes serum levels of enzymes that arise from diseased liver tissue, but correct diagnosis depends on needle biopsy or open biopsy. Prognosis for cancer of the liver is poor because usually the malignancy has developed elsewhere and has spread to the liver.

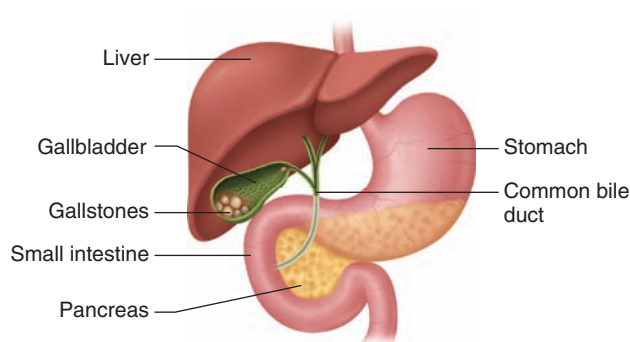


Figure 9–12 ► Gallbladder opening showing gallstones.

Gallstones can be diagnosed and located by ultrasound and x-ray. The usual treatment for gallstones is surgical removal of the gallbladder, a **cholecystectomy**. The cystic duct is ligated and the common bile duct examined for stones. Occasionally, undetected cholesterol stones are retained in the common bile duct after surgery. Administering a solubilizing agent through a catheter into the bile duct may dissolve the remaining stones, preventing the necessity of repeated surgery. Gallstones cannot be prevented.

Diseases of the Gallbladder

Gallstones (Cholelithiasis)

Gallstones are precipitated bile components in the gallbladder and bile ducts. Gallstones and gallbladder disorders (cholecystitis, discussed in the following subsection) are common, affecting about 1 million Americans per year. Gallstones affect twice as many women as men. Risk factors include gender (affects women more often), obesity, age, and family history.

The stones arise in the gallbladder when the bile composition changes or when gallbladder muscle activity reduces, as it may during pregnancy, use of oral contraceptives, diabetes mellitus, obesity, cirrhosis, and pancreatitis. The stones consist principally of cholesterol, bilirubin, and calcium when in excess. Gallstones, also called **biliary calculi**, may be present in the gallbladder and give no symptoms. There may be one gallstone present or several hundred, which can be large or small (Figure 9–12 ►). Small stones, referred to as gravel, can enter the common bile duct and cause an obstruction with excruciating pain.

Cholecystitis

Cholecystitis is an inflammation of the gallbladder usually associated with gallstones (cholelithiasis). Acute cholecystitis is most common in middle age. Risk factors include age, being female, and having gallstones.

Symptoms are related to the swelling of the gallbladder. Pain occurs under the right rib cage that radiates to the right shoulder. At this point, the gallbladder can usually be palpated. Chills and fever, nausea and vomiting, belching, and indigestion are symptoms; in chronic cholecystitis these symptoms occur especially after eating fatty foods. The presence of fat in the duodenum stimulates the gallbladder to contract, which causes pain. Prolonged inflammation causes the walls of the gallbladder to thicken, making it impossible for the gallbladder to contract properly. Serious complications can result from cholecystitis. Lack of blood flow because of the obstruction brought about by the swelling can cause an infarction. With the death of the tissues, gangrene can set in. An acutely inflamed gallbladder might require surgical removal.

A complication of chronic cholecystitis is that bile accumulates in the bile ducts of the liver. This causes necrosis and fibrosis of the liver cells lining the ducts. This is another form of cirrhosis, **biliary (bile) cirrhosis**.

Diseases of the Pancreas

Pancreatitis

Acute **pancreatitis** is a serious, painful inflammation of the pancreas. Pancreatitis is more prevalent in women than in men and usually occurs after age 40. In men it is often associated with alcoholism or peptic ulcers. In women it is more commonly associated with gallbladder disease. The prognosis is good if pancreatitis is associated with gallbladder disease but is very poor if it is related to alcoholism. Pancreatitis may be caused by local swelling, necrosis, hemorrhage, or trauma.

Severe, steady abdominal pain of sudden onset is the first symptom. The intense pain radiates to the back and resembles the sharp pain of a perforated ulcer. Drawing up the knees or assuming a sitting position may provide some relief. There may also be nausea and vomiting. Jaundice sometimes develops if the swelling blocks the common bile duct. If a large area of the pancreas is affected, both endocrine and digestive functions of the gland become impaired. In the absence of lipid enzymes from the pancreas, fat cannot be digested, resulting in greasy stools with a foul odor. Secondary malabsorption syndrome develops because fat that is not digested cannot be absorbed. In pancreatitis, the protein- and lipid-digesting enzymes become activated within the pancreas and begin to digest the organ itself. Severe necrosis and edema of the pancreas result. The digestion can extend into blood vessels, which causes severe internal bleeding and shock. When the condition becomes this severe, it is called acute hemorrhagic pancreatitis.

The most significant diagnostic procedures for pancreatitis are blood and urine tests for elevated pancreatic enzymes such as lipase and amylase. Stool may be tested for levels of fat, and an abdominal CT or ultrasound may be used to visualize the extent of inflammation. Treatment requires hospitalization, a few days of fasting,

intravenous fluids, and analgesics. The underlying cause of the pancreatitis may require treatment. To reduce the risk of pancreatitis, one should stop smoking, stop drinking alcohol, and ensure good hydration.

Cancer of the Pancreas

Cancer of the pancreas, **adenocarcinoma**, has a high mortality rate. It occurs more frequently in males than in females and is most prevalent in men between the ages of 35 and 70. Pancreatic cancer is linked to cigarette smoking, high-protein and -fat diets, food additives, and exposure to industrial chemicals such as beta-naphthalene, benzidine, and urea. Chronic alcohol abuse, chronic pancreatitis, and diabetes mellitus increase the risk of developing pancreatic cancer.

A malignancy in the head of the pancreas can block the common bile duct (Figure 9–13 ►), and symptoms are experienced earlier than those of cancer in the body or tail of the pancreas, which can be very advanced before it is discovered. Obstruction of the bile duct causes jaundice and impairs digestion because the pancreatic enzymes and bile cannot enter the duodenum.

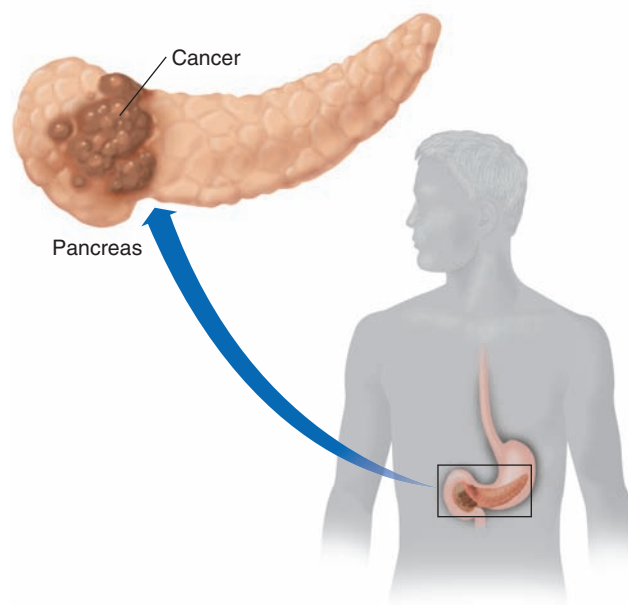


Figure 9–13 ► Pancreatic cancer. A common site of pancreatic cancer is in the head of the pancreas within the pancreatic ducts.

This causes malabsorption of fat and clay-colored stools; sufficient nutrients and calories cannot be absorbed, and weight loss occurs. Great pain is experienced as the tumor grows, and the cancer usually metastasizes to the surrounding organs: the duodenum, stomach, and liver.

Diagnosis depends on laparoscopic biopsy and ultrasound. Prognosis for cancer of the pancreas is poor, and death occurs in a relatively short time. Treatment, which is rarely successful, includes surgery, chemotherapy, and radiation. Pancreatic cancer cannot be prevented.

Age-Related Diseases

Infants and young children are especially vulnerable to the effects of digestive system disorders and diseases because their growing and developing bodies require substantial fluids, calories, and nutrients. For example, unchecked vomiting and diarrhea can cause dehydration and malnutrition more easily in children than in adults. The digestive system functions fairly well in healthy older adults, despite normal age-related changes such as thinning mucosa and decreased muscle motility. However, some diseases such as cancer occur with greater frequency with increasing age and thus significantly impact older populations.

Mouth and Esophagus

Dental caries (cavities) are more prevalent in children than in adults. After adolescence, the incidence of caries reduces and the risk for gingivitis and periodontal disease increases. Periodontal disease and osteoporosis contribute to tooth loss in older adults. The number of taste buds decreases, and together with decreased saliva secretion, this may lead to decreased appetite. Esophageal cancer incidence is highest in those over age 60. As stated earlier, this cancer is closely linked with the use of alcohol and tobacco.

Gastrointestinal Tract

Infectious diarrheal diseases are the leading cause of death in children worldwide. Children cannot tolerate the loss of enormous amounts of water, electrolytes, and nutrients associated with diarrhea. Hiatal hernia is a common disorder in

older adults. Peptic ulcers are no more common in older than in middle-age people; however, the risk of hemorrhage is greater in old age. Colon cancer incidence increases after age 45, which emphasizes the importance of regular screening and early diagnosis. Diverticula are most common in older adults, and therefore the incidence of diverticulitis rises. Diarrhea poses a great risk of dehydration and malnutrition. Therefore, gastrointestinal infections such as food poisoning and dysentery can be serious diseases. Overall, the function of the intestines remains fairly normal, although intestinal motility is slightly decreased. Thus, changes in diet or new medications that affect intestinal motility can more easily lead to constipation or diarrhea.

Liver and Gallbladder

Liver and gallbladder disorders are uncommon in children. In adulthood, liver function diminishes with increasing age, which results in the persistence of high blood levels of medications or toxins. In old age, levels of clotting factors decline, increasing the risk for hemorrhage. The incidence of cholelithiasis is highest in those over age 80.

Pancreas

Pancreatic disorders in children are uncommon, although insulin-dependent (Type 1, or juvenile-onset) diabetes does begin in childhood. Type 2, formerly called adult-onset diabetes, is now increasingly occurring in children (as well as in adults) as a result of obesity. The incidence of pancreatic cancer peaks in the 60s and is most common among older men. Acute pancreatitis is common in older adults. In younger people, acute pancreatitis is associated with alcoholism, while in older adults acute pancreatitis is more likely due to gallstones that block the pancreatic duct.

Resources

American Cancer Society: www.cancer.org
 American Gastroenterological Association: www.gastro.org
 American Liver Society: www.liversociety.org
 National Institute of Health, National Digestive Diseases
 Information Clearinghouse: www.digestive.niddk.nih.gov

Diseases at a Glance

Digestive System

Disease	Etiology	Signs and Symptoms
Stomatitis	Bacteria, viruses, fungi	Redness, ulcers, patches, bleeding, depending on the cause
Cancer of the mouth	Use of tobacco products, especially in conjunction with consuming alcohol	Abnormal growths, sores, or lesions that don't heal
Cancer of the esophagus	Use of tobacco and alcohol	Dysphagia, vomiting, weight loss
Esophagitis	Acid reflux due to incompetent cardiac sphincter	Burning chest pain (heartburn), especially after eating or while lying down
Esophageal varices	Increased venous pressure; accompanies advanced cirrhosis	Dilated esophageal veins, hemorrhage
Hiatal hernia	Stomach protrudes through weakened diaphragm	Indigestion, heartburn following meals, acid reflux, and esophagitis
Gastritis	Aspirin, coffee, tobacco, alcohol, infection	Stomach pain, hematemesis
Chronic atrophic gastritis	Degeneration of stomach mucosa results in no HCl secretion and no intrinsic factor secretion	Gastritis, poor digestion and absorption of nutrients, weight loss
Peptic ulcer	Infection with <i>H. pylori</i> and erosion of mucosa by stomach acid	Upper abdominal pain, hemorrhage, blood in stool
Gastroenteritis	Food- and waterborne infection by bacteria, viruses, protozoa	Nausea, vomiting, diarrhea, abdominal discomfort or pain, and possibly fever, depending on the pathogen
Cancer of the stomach	Idiopathic; associated with salted, cured foods and diet low in vegetables and fruit; associated with prior infections with <i>H. pylori</i>	Appetite loss, stomach discomfort, hematemesis, blood in stool, late-stage pain

Diagnosis	Treatment	Prevention
Physical exam, immunodiagnostic tests, and pathogen culture	Antibiotics, antivirals, or antifungals, depending on the pathogen	Good oral hygiene; do not use antibiotics unnecessarily or incorrectly
Physical exam, biopsy	Surgical excision of tumor, radiation	Avoid tobacco products; use alcohol only in moderation
EGD endoscopy and esophageal washings	Surgery, radiation, chemotherapy	Avoid tobacco products; use alcohol only in moderation
Physical exam	Nonirritating diet, antacids, acid-reducing medications	Take small meals; avoid known irritants
EGD endoscopy, physical exam, history of alcoholism	Vasopressin or other medicines to reduce bleeding; bypass of portal veins	Treat underlying alcoholism or liver disease
CT, EGD endoscopy	Avoid irritating foods, eat frequent small meals, surgery to repair diaphragm	Avoid spicy food, caffeine; eat small meals
EGD endoscopy	Avoid irritants, drink ice water, antacid medications; surgery to control bleeding	Avoid known irritants
Analysis of stomach content reveals low levels of HCl and intrinsic factor	Avoid stomach irritants, vitamin B ₁₂ supplements	Avoid known irritants
EGD endoscopy, gastric washings	Antibiotics	Reduce stress
Stool culture, history	Fluid and electrolyte replacement; antidiarrheal medication; self-limiting in healthy people	Safe food handling, including correct storage, refrigeration, and thorough cooking as needed
EGD endoscopy, biopsy, gastric fluid analysis (low HCl), barium x-ray	Surgery, chemotherapy	Reduce intake of salt and cured meat

Disease	Etiology	Signs and Symptoms
Appendicitis	Obstruction with fecal material leads to infection, inflammation, and necrosis	Acute lower right quadrant abdominal pain, nausea, fever
Malabsorption syndrome	Congenitally abnormal intestinal mucosa or malabsorption secondary to diseases of pancreas or gallbladder	Malnutrition, failure to absorb fats and fat-soluble vitamins, failure to grow in children and weight loss in adults
Diverticulitis	Diverticula of colon become impacted with fecal material and infected or inflamed	Cramping and pain in lower abdomen
Regional enteritis (Crohn's disease)	Idiopathic; possible link to autoimmune disease	Lower right pain, diarrhea and constipation, emission and exacerbation, weight loss, melena
Chronic ulcerative colitis	Idiopathic; may be autoimmune, stress related, food allergy related	Diarrhea; pus, blood, mucus in stool; cramping in lower abdomen
Cancer of colon and rectum	Genetic; associated with familial polyposis and chronic ulcerative colitis	Change in bowel habits, diarrhea or constipation, blood in stool
Spastic colon/irritable bowel syndrome	Abuse of laxatives; irritating foods; stress	Diarrhea, pain, gas, constipation
Dysentery	Food- or waterborne intestinal infection by bacteria or protozoa	Abdominal pain, bloody diarrhea with pus and mucus
Viral hepatitis A (infectious hepatitis)	Food- or waterborne infection with hepatitis A virus	Anorexia, nausea, mild fever, jaundice, enlarged tender liver
Hepatitis B (serum hepatitis)	Bloodborne or sexually transmitted infection with hepatitis B virus	Two- to 6-month incubation period followed by anorexia, nausea, mild fever, jaundice, enlarged tender liver; may lead to chronic hepatitis and cirrhosis
Hepatitis C	Bloodborne or sexually transmitted infection with hepatitis C virus	Symptoms as for hepatitis A and hepatitis B following incubation period of months to decades; commonly results in cirrhosis and end-stage liver disease
Hepatitis D	Rare bloodborne or sexually transmitted co-infection with hepatitis D virus and hepatitis B virus	Same as for hepatitis B; more serious and frequently progresses to chronic liver diseases
Hepatitis E	Waterborne infection with hepatitis E virus rare in United States	As for hepatitis A

Diagnosis	Treatment	Prevention
Blood count, physical exam	Surgery	Maintain good bowel habits
Stool analysis, endoscopy, and history	Manage diet; vitamin supplements	Treat underlying diseases
Endoscopy	Antibiotics, manage diet	Good bowel habits
Stool analysis, endoscopy, patchy thickening of intestinal wall	Corticosteroids, surgery	None
Stool analysis, endoscopy, diffuse thickening of colon (pipestem colon)	Corticosteroids, stress reduction, diet management, colostomy	Reduce stress
Endoscopy, biopsy, barium x-ray, stool analysis	Surgery, radiation, chemotherapy	Regular screening to include endoscopy and biopsy if at risk
History and physical exam; no lesions present	Avoid caffeine, alcohol, spicy food, fat; increase fiber in diet; reduce stress	Avoid laxatives
Stool culture and history	Antibiotics if bacterial and amebicides if caused by protozoa	Safe food and water handling
Physical exam, stool analysis, immunodiagnosics	Immunoglobulin injections for exposures and infections	Vaccine; safe food and water handling
Physical exam, stool analysis, immunodiagnosics	Immunoglobulin injections for exposures and infections, antiviral medications, vaccine for prevention	Vaccine
Physical exam, stool analysis, immunodiagnosics	Ribavarin, interferon, liver transplant	Safe sex, avoid injection drug abuse
Physical exam, stool analysis, immunodiagnosics	Immunoglobulin injections, antiviral	Safe sex, avoid injection drug use
Physical exam, stool analysis, immunodiagnosics	No treatment, no vaccine	Safe food and water handling

Disease	Etiology	Signs and Symptoms
Cirrhosis	Alcohol-induced damage to liver; hepatitis	Jaundice, abdominal distension, ascites, bleeding tendencies, edema, malabsorption of fats, gynecomastia, delirium tremens, hepatic coma
Cancer of the liver	Primary carcinoma is complication of cirrhosis; more common is secondary or metastatic	Bile duct obstruction, jaundice, impaired clotting, ascites, weight loss
Cholecystitis	Obstruction by infection/inflammation or by tumor	Upper right abdominal pain especially following a meal of fatty food; nausea, indigestion, belching
Cholelithiasis	Related to obesity; higher incidence in pregnancy and among women	None, or upper right abdominal pain especially following a meal
Pancreatitis	Idiopathic, commonly associated with excessive alcohol consumption or with gallstones	Acute, severe, sharp, radiating abdominal pain; risk of hemorrhage; jaundice; vomiting; malabsorption
Cancer of the pancreas	Linked to cigarette smoking, alcohol abuse, chemical carcinogens, chronic pancreatitis, diabetes mellitus	Malabsorption, jaundice, upper abdominal pain

Diagnosis	Treatment	Prevention
Patient history, physical exam, serum liver enzyme levels	No specific treatment; symptomatic treatment for edema and portal hypertension or bleeding; improved diet, liver transplant	Treat underlying alcoholism or liver disease
Ultrasound, CT scan, needle biopsy	Chemotherapy (prognosis poor)	None
Ultrasound, CT scan, fecal fat test	Cholecystectomy	None
Ultrasound, CT scan, fecal fat test	Cholecystectomy, administration of solubilizing agent into bile duct	Reduce weight
Ultrasound, CT scan, serum pancreatic enzymes	No specific treatment; analgesics, fluid replacement, IV nutrients	Treat underlying alcoholism
Ultrasound, CT scan, needle biopsy	Chemotherapy (prognosis poor)	Stop tobacco use, alcohol abuse, treat underlying diabetes

Interactive Exercises

Cases for Critical Thinking

1. A 45-year-old woman experiences frequent heartburn, difficulty swallowing, and sharp pains below her sternum. At night, she experiences gastric reflux, or a regurgitation of stomach acid into the esophagus, a condition that is extremely painful. What could produce these symptoms? What diagnostic procedures could be used? How should she be treated?
2. T. W. experiences sharp pain in his upper right abdomen after eating a high-fat meal.

Also, he has noted that his feces are grayish white instead of brown. What disease is the likely cause of his symptoms? Explain why each of these symptoms occurs with this disease.

3. Explain how cirrhosis leads to each of these signs and symptoms: jaundice, malnutrition, hemorrhage, esophageal varices.

Multiple Choice

1. Which of the following is a sign of gastritis?
 - a. constipation
 - b. inflammation of stomach mucosa
 - c. achlorhydria
 - d. diarrhea
2. Recurrent bloody diarrhea may be a symptom of _____.
 - a. gastric ulcer
 - b. ulcerative colitis
 - c. hiatal hernia
 - d. esophagitis
3. Which disease is characterized by the destruction of intestinal villi, leading to inability to absorb fats and other nutrients?
 - a. ulcerative colitis
 - b. celiac disease
 - c. Crohn's disease
 - d. peptic ulcer
4. Small pouches of the large intestine become inflamed during which disease?
 - a. Crohn's disease
 - b. gastritis
 - c. hemorrhoids
 - d. diverticulitis
5. Which statement about pancreatic cancer is false?
 - a. It is characterized by abdominal pain, weakness, and weight loss.
 - b. It has a higher incidence with age.
 - c. Most cancers are diagnosed after the cancer has metastasized.
 - d. The prognosis is good with an 85% cure rate.
6. Which statement about cirrhosis is false?
 - a. Irreversible degenerative changes occur in the liver.
 - b. The normal liver tissue is replaced with fibrous scar tissue.
 - c. It is most often caused by diabetes.
 - d. It is associated with esophageal varices.
7. Acute pancreatitis is most closely associated with _____.
 - a. hepatitis C virus infection
 - b. chronic alcoholism
 - c. bile duct obstruction
 - d. complication of cirrhosis
8. Esophageal varices arise in which disease?
 - a. cirrhosis
 - b. pancreatic cancer
 - c. cholecystitis
 - d. cholelithiasis

9. Oral thrush is caused by _____.

- a. *Candida albicans*
- b. herpes simplex virus type 1
- c. *Treponema pallidum*
- d. *Streptococcus pyogenes* virus type 1

10. Pain in the upper right quadrant, especially after eating, could be a sign of _____.

- a. appendicitis
- b. pancreatitis
- c. cholecystitis
- d. colitis

True or False

- _____ 1. Hemorrhoids are caused by infection with *E. coli*.
- _____ 2. Oral and esophageal cancers are linked to tobacco and alcohol use.
- _____ 3. Drinking too much water causes diarrhea.
- _____ 4. Dark stools are known as melena.
- _____ 5. Neurologic disorders can accompany liver disease.

- _____ 6. Hepatitis A is acquired through blood products.
- _____ 7. Most cancer in the liver is primary liver cancer.
- _____ 8. Gallstones are made of undigested food particles too large to pass.
- _____ 9. There is no vaccine for hepatitis B.
- _____ 10. Gastric ulcers are caused by infection with *Helicobacter pylori*.

Fill-Ins

- 1. *Entamoeba histolytica* is the cause of _____.
- 2. Thickened intestinal walls, leading to obstruction and abdominal pain, are found in _____.
- 3. An abdominal _____ is protrusion of an organ through the abdominal wall muscles.
- 4. An instrument called a(n) _____ is used to view the lining of the esophagus or other organs of the digestive tract.
- 5. Hepatitis type _____ is the major viral cause of cirrhosis.

- 6. Cholecystectomy is used to treat _____.
- 7. Biliary cirrhosis arises if there is obstruction of the _____.
- 8. Accumulation of fluid in the abdomen is called _____.
- 9. Stomatitis refers to inflammation of the _____.
- 10. The primary function of the _____ is to absorb water.

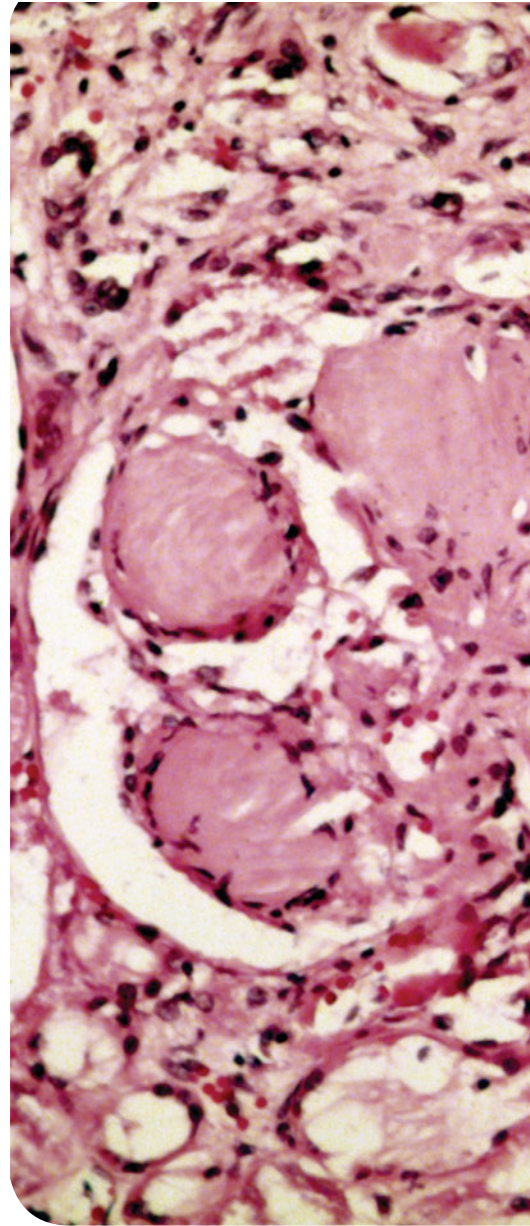
Chapter 10

Diseases and Disorders of the Urinary System

Learning Objectives

After studying this chapter, you should be able to

- Describe the anatomy and the functions of kidneys, nephrons, ureters, urinary bladder, and urethra
- Identify the etiology, signs and symptoms, diagnostic tests, and treatment for acute kidney injury and other acute and inflammatory diseases of the urinary system
- Know the etiology, and describe the signs and symptoms, diagnostic tests, and treatment of urinary tract infections
- Identify the etiology, signs and symptoms, diagnostic tests, and treatment for chronic kidney disease, hypertensive kidney disease, diabetic nephropathy, nephrotic syndrome, end-stage renal disease, and other chronic diseases of the urinary system
- Describe kidney dialysis
- Recognize the etiology, signs and symptoms, and modes of treatment for renal cell carcinoma, Wilms' tumor, and bladder cancer
- Describe common congenital disorders of the urinary system
- Describe common age-related diseases of the urinary system

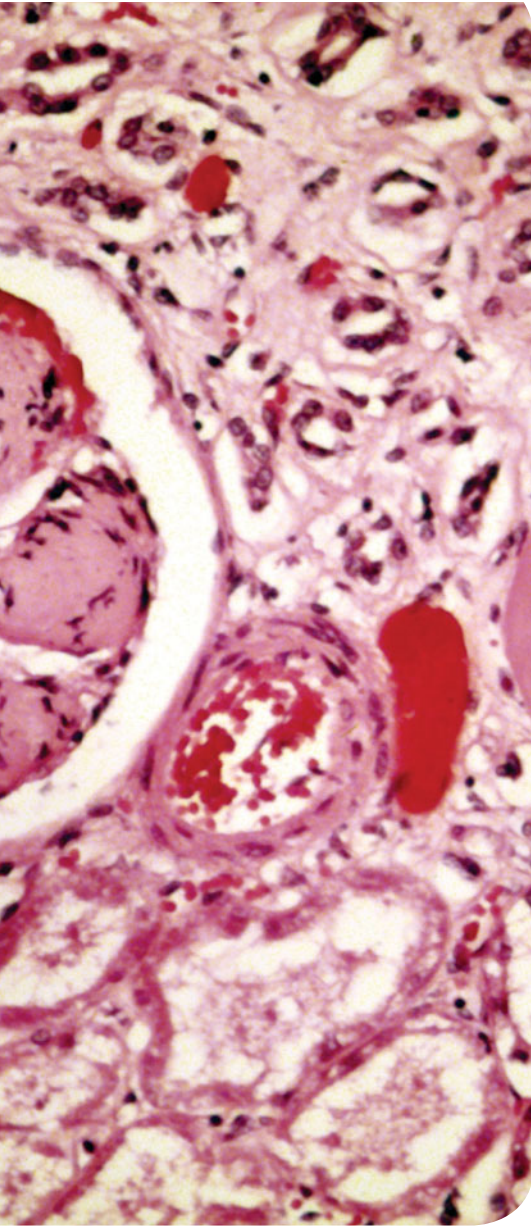


Histopathology of kidney showing nodular glomerulosclerosis characteristic of diabetes mellitus. (Courtesy of the Centers for Disease Control and Prevention/Dr. Edwin P. Wing, Jr., 1974)

Fact or Fiction?

Kidney stones occur only in the kidneys.

Fiction: Kidney stones may form anywhere within the urinary system, but they usually form in the renal pelvis or calyces of the kidney and they can lodge in the ureters.



Disease Chronicle

What's in a Name?

Many anatomical structures once bore the names of the scientists who first discovered them. Recently anatomists have revised anatomical nomenclature and we no longer formally name organs after scientists. Instead, we apply descriptive anatomical terminology to structures. The glomerulus or renal corpuscle was formerly known as the malpighian corpuscle, named for Italian anatomist Marcello Malpighi (1628–1694) who first published a description of the glomerulus. One of the microscopic filtration tubules now called the renal loop was for many years named the loop of Henle, for Friedrich Gustav Jakob Henle, who described it in 1862.

Anatomy and Physiology Review

The organs of the urinary system filter the blood, form and store urine, and excrete urine from the body. The urinary system is comprised of two kidneys and ureters, a urinary bladder, and a urethra. The two kidneys are retroperitoneal, located behind the peritoneum of the posterior abdominopelvic cavity. Leading from each kidney is a ureter that drains urine to the urinary bladder, located on the floor of the pelvic cavity. The urethra drains urine from the urinary bladder to the outside.

The kidneys are critical for homeostasis. Kidneys continually remove waste and toxins from the blood, regulate water and electrolyte levels, and control pH and blood pressure. Kidneys also produce renin, which regulates blood pressure, and erythropoietin, which stimulates red blood cell production. Kidneys produce approximately 1 milliliter of urine per minute. In doing so, 20–25% of the body's blood volume flows within the kidneys at any given time.

The Nephron

The functional unit of the kidney is the **nephron**. Approximately a million nephrons reside within each kidney. As blood passes through the nephrons, metabolic waste products are filtered from the blood plasma. At the same time, most of the water (99%) is reabsorbed, along with nutrients such as glucose and amino acids. Extra water, excess ions, acid, some drugs, and metabolic wastes such as urea and creatinine are excreted. The hormones **aldosterone** and **antidiuretic hormone (ADH)** play important roles in the regulation of the nephron's ability to reabsorb salt and water.

Each nephron consists of an afferent arteriole, an efferent arteriole, a **glomerulus**, a glomerular capsule, a proximal convoluted tubule, a renal loop (loop of Henle), and a distal convoluted tubule that leads to a collecting duct. The components of the nephron are shown in Figure 10–1 ►.

The afferent arteriole carries blood into the nephron and enters the glomerulus, a network of specialized selectively permeable capillaries,

where blood is filtered into the surrounding glomerular capsule. This filtrate contains fluid from plasma and some of its constituents. As the filtrate continues on through the proximal renal tubule, renal loop, and distal renal tubule, its composition is altered. Much water is retained (reabsorbed into nearby capillaries), as are glucose and electrolytes. Acid and urea are not reabsorbed. Instead, these are excreted and move with the filtrate to the collecting ducts, forming urine. Normal urine does not contain blood cells, plasma proteins, or glucose.

Urine from the collecting ducts of the nephrons eventually empties into the renal calyces and **renal pelvis** at the junction of the kidneys with the **ureters**, and moves down the ureters to the urinary bladder. Neural signals governing **micturition** stimulate the bladder to empty urine into the urethra, which leads outside the body. Figure 10–2 ► illustrates the urinary system.

Diagnostic Tests and Procedures

History and Physical Exam

Diagnosis of urinary system diseases requires assessing patient history. Important factors include the presence of other diseases, especially diabetes, hypertension, and urinary tract infections. A history should also determine exposure to medicines, antibiotics, and kidney toxins or abuse of analgesics such as acetaminophen. Diagnostic information can be gathered from patient reports about fever, pain, and urine volume, frequency, or color. Family history of renal diseases can indicate a genetic predisposition for certain diseases.

A physical exam can reveal renal disease because the entire body is affected. For example, edema can be detected in skin, around the eyes, and on the ankles. As toxins accumulate in the blood, neurologic abnormalities arise, including disorientation and changes in consciousness and response to stimuli. Changes in electrolyte levels occur with renal disease, causing hypertension and a strong, irregular pulse. Alterations in pH levels result in acidosis, which triggers hyperventilation.

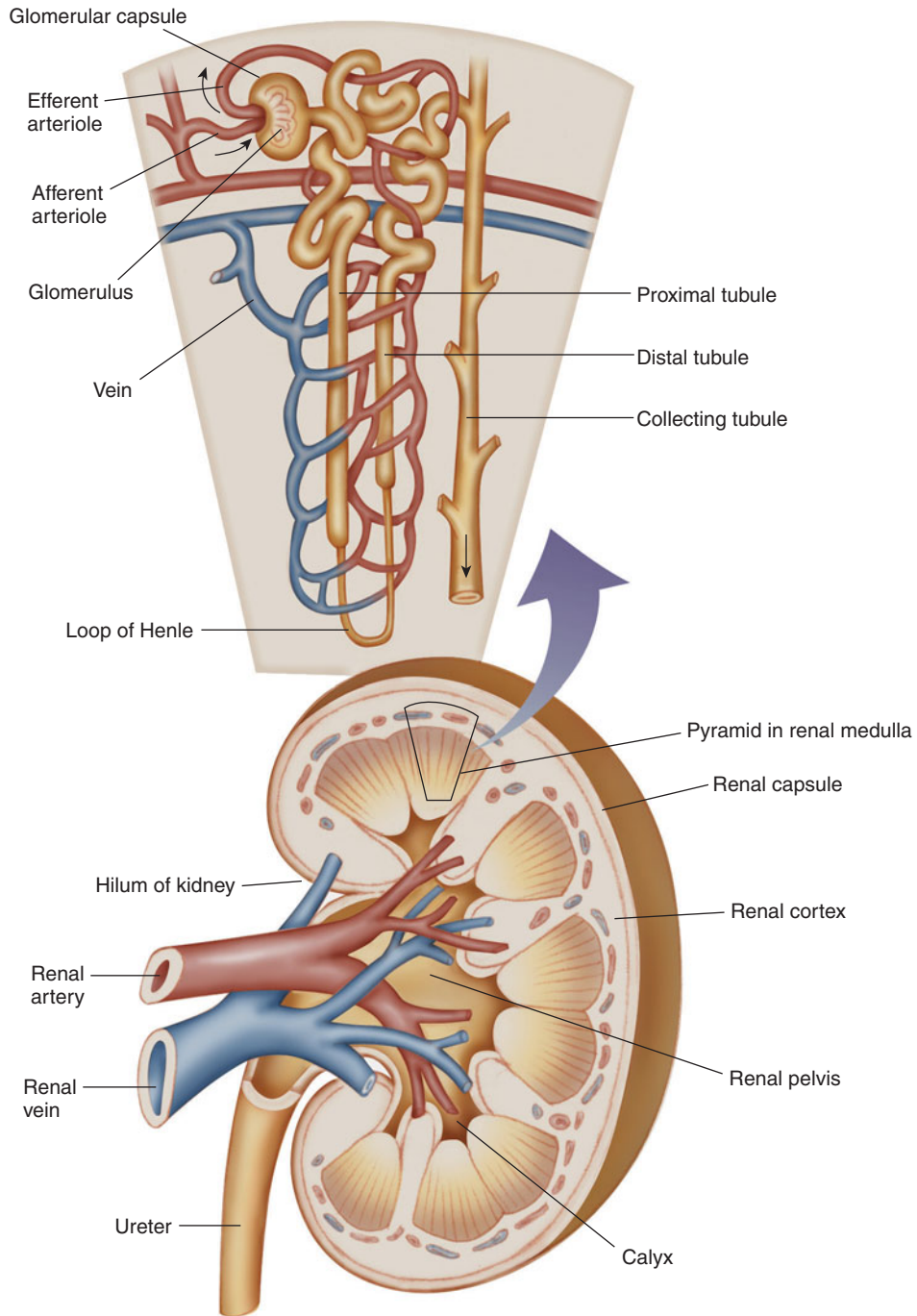


Figure 10-1 ► The kidney with an expanded view of the nephron.

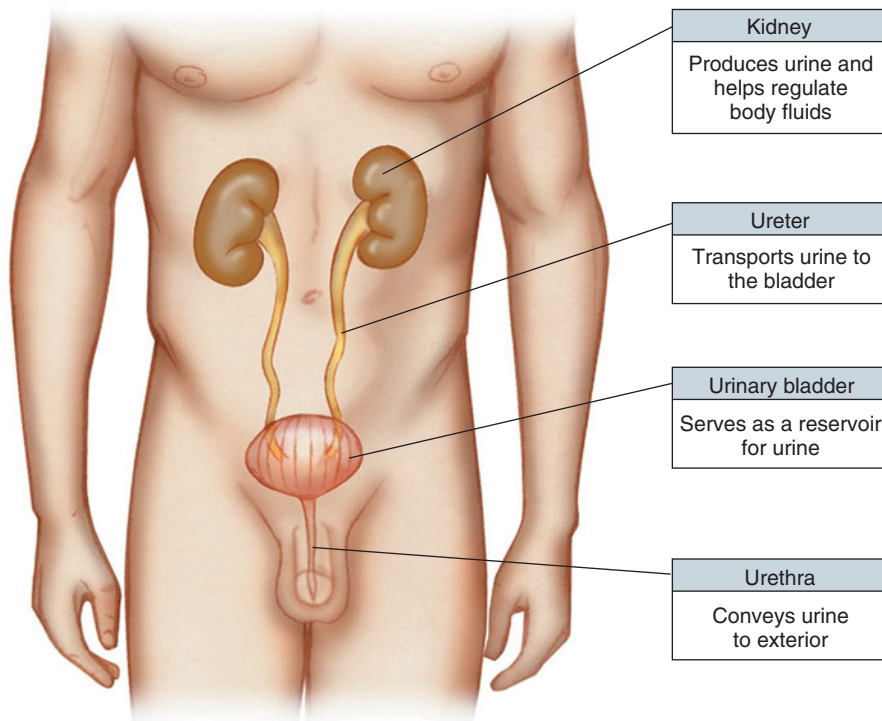


Figure 10-2 ► The urinary system.

Urinalysis and Laboratory Tests

Renal disease can be detected through analysis of blood for creatinine, uric acid, and blood urea nitrogen. Significant diagnostic information can be obtained by urinalysis, in which a urine specimen is studied physically, chemically, and microscopically. Physical factors include urine color, clarity, odor, pH, and specific gravity. The color of normal urine ranges from pale yellow to amber.

The color and volume of urine may indicate disease. For example, diabetics produce large volumes of pale and dilute urine. In chronic kidney diseases, the ability of the renal tubules to concentrate urine is absent. As a result, the urine is dilute and pale, and the specific gravity is low. The presence of red blood cells imparts a reddish-brown color to urine.

Chemical tests may employ a urine dipstick to detect a variety of chemicals. For example, albumin in the urine (albuminuria) can indicate inflammation of the urinary tract, particularly of the glomeruli. The presence of glucose in the urine is one of the signs of diabetes mellitus.

Urine is centrifuged and examined microscopically for red blood cells, white blood cells, bacteria, crystals, and casts. Casts form within kidney tubules from which the casts take their cylindrical forms. Casts consist of coagulated protein, blood cells, and epithelial cells.

Imaging Techniques

Ultrasound and CT allow visualization of the kidneys, ureters, and bladder. A cystoscopic examination enables visualization of the inside of the bladder and urethra. The cystoscope is a long, lighted instrument resembling a narrow hollow tube inserted through the urethra into the bladder.

Acute Diseases and Disorders

Acute Kidney Injury

Acute kidney injury is the sudden onset of impaired renal function. Acute kidney injury has three main causes. One is shock, which

interrupts blood flow to the kidneys. Second is tubular necrosis, which results in a number of diseases such as systemic lupus erythematosus, sickle cell disease, renal vein thrombosis, acute poststreptococcal glomerulonephritis, or exposure to toxins. Third is obstructed urine flow, a condition arising with kidney stones, an inflamed prostate, or tumors.

Significant signs of acute kidney injury include oliguria (low urine output), a sudden drop in urine volume, and rarely a complete cessation of urine production, a condition called **anuria**. Systemic symptoms arise as the body fails to clear toxins and acid from the blood. Symptoms include nausea, vomiting, diarrhea, and the odor of ammonia on the breath caused by accumulation in the blood of nitrogen-containing compounds. Headache, drowsiness, confusion, neuropathy, seizures, and coma may occur if untreated. At first low blood pressure occurs, then hypertension and heart failure and respiratory edema. **Hyperkalemia**, a condition of elevated blood potassium, can cause cardiac arrest.

Diagnosis includes a history to determine the presence of other diseases or exposure to toxins or medicines that are known to trigger acute kidney injury. Blood tests will reveal elevated blood urea nitrogen, serum creatinine, potassium, and low pH, all of which are signs of the kidneys' failure to clear these substances and acid from the blood. Urinalysis will reveal casts, low specific gravity, and possibly proteinuria. An ultrasound may be used to visualize renal damage.

Treatment includes a diet low in protein, sodium, and potassium, restricted fluid intake, and dialysis if needed. Hyperkalemia requires dialysis and IV medications that remove potassium. The prognosis is favorable if treatment begins early. Acute kidney injury can be prevented by treating the causative diseases and by avoiding known kidney toxins.

Urinary Tract Infections

Urinary tract infections (UTIs) are caused primarily by bacteria from the skin or colon. Bacteria that colonize the urethra usually become dislodged by regular flow of urine. If not cleared from the urethra, bacteria can ascend the urethra and infect the urinary bladder and the kidneys. UTIs can occur when urine flow is reduced,

during catheterization, or following poor hygiene. Because females have a shorter urethra, the prevalence of UTIs is greater in females than in males.

Lower UTIs: Urethritis and Cystitis Urethritis and **cystitis** are fairly common UTIs. Urethritis is inflammation of the urethra and cystitis is inflammation of the urinary bladder. Risk factors include being female, having multiple sex partners, and having sexually transmitted infectious diseases. The symptoms of urethritis include a discharge from the urethra, an itching sensation at the opening of the urethra, and a burning sensation during urination. Cystitis is characterized by urinary frequency, a sense of urinary urgency, and **dysuria**, a painful, burning sensation during urination. Other symptoms include low fever and pressure with pain in the lower back. The primary cause of lower UTIs is a bacterial infection. Treatment includes antibiotics. Lower UTIs can be prevented by staying hydrated to promote urine flow, practicing front-to-back wiping after urinating, and safe sex.

Upper UTIs **Pyelonephritis** is inflammation of the kidney. Risk factors include being female, kidney stones, having a urinary catheter, or immunodeficiency. In pyelonephritis, infected abscesses form and rupture, draining pus into urine. Pus in the urine is called **pyuria**, which makes the urine sample turbid or cloudy. Symptoms of pyelonephritis include chills, high fever, sudden back pain that spreads over the abdomen, **dysuria**, and hematuria. Microscopic examination of the urine reveals numerous pus cells and bacteria. The abscesses can fuse, filling the entire kidney with pus. Figure 10-3 ► shows how pyelonephritis develops. Pyelonephritis is often caused by pyogenic (pus-forming) bacteria, such as *Escherichia coli*, streptococci, and staphylococci.

Left untreated, pyelonephritis may lead to uremia and renal failure. Less severe infections heal and form scar tissue. Treatment includes antibiotics. Prevention relies on prompt treatment of infections in the bladder and lower urinary tract.

Inflammatory Kidney Diseases

Immune system-mediated inflammation of the kidney may occur in the absence of infection.

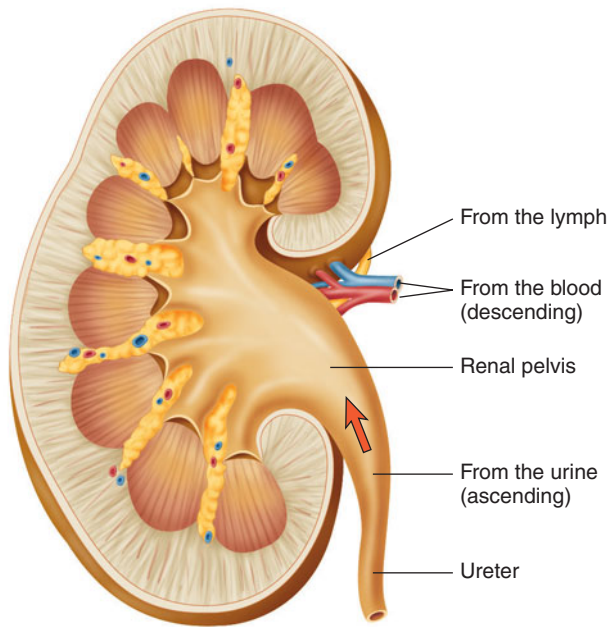


Figure 10-3 ▶ Routes of infection for pyelonephritis.

Here we discuss these inflammatory conditions, which may be considered autoimmune diseases because the immune system causes kidney inflammation and injury.

Lupus Nephritis Lupus nephritis is an inflammatory disease of the kidney. Nephritis occurs in about 45% of those with systemic lupus erythematosus. Symptoms and signs include hematuria, hypertension, and joint pain.

Diagnosis of lupus nephritis begins with a patient history, physical exam, and evaluation of symptoms. Lab tests include urinalysis, blood tests, ultrasound, and might include kidney biopsy to determine the type of kidney injury. Treatment involves anti-inflammatory drugs and immune-suppressants. Hypertension must be treated with statins or ACE inhibitors and a reduced-fat and low-salt diet. Renal transplant may be performed if the kidney function does not recover. Prevention is not possible, but risk can be reduced by adequate treatment of systemic lupus erythematosus.

IgA Nephropathy IgA nephropathy is an inflammatory disease of the kidney resulting from

immunoglobulin A (IgA) deposition in the glomeruli. IgA nephropathy is more common in men, especially those in their late teens to early 30s, although it affects all age groups. IgA nephropathy is a common cause of glomerulonephritis. Because it takes years to become recognized and cause complications, younger people seldom display symptoms. The most common early symptoms are blood in the urine and later swelling of the hands and feet.

Diagnosis involves tests for blood urea nitrogen, urinalysis, and renal biopsy. No treatment is recommended for mild cases with normal blood pressure and proteinuria, but elevated blood pressure requires hypertension medications. Prevention is not possible.

Glomerulonephritis Glomerulonephritis (GN) is an inflammatory disease of the glomeruli. GN is a condition that arises from a variety of underlying diseases and disorders, and its prevalence is not well known. However, GN is the second leading cause of renal failure. In GN, most glomerular injury results from inflammatory conditions. Acute GN usually affects children 1–4 weeks following a streptococcal infection of the skin or throat. In contrast, chronic GN usually follows chronic kidney disease. Risk factors for GN include diabetes, hypertension, and streptococcal infection.

Acute Poststreptococcal Glomerulonephritis Acute poststreptococcal GN is an inflammatory GN caused by an antigen–antibody reaction that occurs approximately 1–4 weeks following a streptococcal skin infection or throat infection. Antigens from the streptococci and the antibodies form complexes in the bloodstream that become trapped within the glomeruli, triggering an inflammatory response and damage to the glomerulus, impairing its filtration function (Figure 10-4 ▶ and Figure 10-5 ▶). The symptoms include chills and fever, loss of appetite, and a general feeling of weakness. There may be edema in the face and ankles.

Acute poststreptococcal GN is diagnosed using a patient history, urinalysis, physical examination, and a renal biopsy. Treatment depends on the cause and usually involves anti-inflammatory drugs and immune suppressants. It may also be

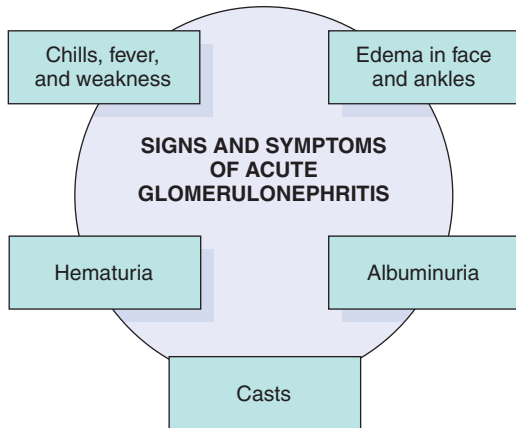


Figure 10-4 ► Signs and symptoms of acute glomerulonephritis.

necessary to treat hypertension. The prognosis is good, with most cases resolving with prompt treatment. Prevention requires prompt treatment for streptococcal infections.

Kidney Stones

Kidney stones are deposits of minerals within the kidney. The stones, called **urinary calculi** or **uroliths**, occur in 9% of adults in the United

States. Men are four times more likely than women to produce renal calculi, with the first episodes occurring between ages 20 and 40.

Urinary calculi may cause no symptoms, even when passed through the urinary tract, unless they are larger than a quarter inch in diameter, in which case they become lodged in the ureter. The lodged stones cause intense pain that radiates from the kidney to the groin area. In addition to intense pain, other signs and symptoms include hematuria, nausea, vomiting, and diarrhea.

Kidney stones may cause urinary tract infections by blocking urine flow and permitting bacterial growth in the urinary tract. A large kidney stone is illustrated in Figure 10-6 ►. Stones can also form in the urinary bladder. The presence of bladder stones causes urinary tract infections because they frequently obstruct the flow of urine.

Diagnosis relies on CT and renal ultrasound. Urinary calculi may be treated with medication that partially dissolves the stone, permitting it to be passed in the urine. **Lithotripsy**, the crushing of kidney stones, is particularly effective for the 20% of kidney stones that do not pass on their own. In lithotripsy, sonic vibrations are applied externally, and focused internally, to

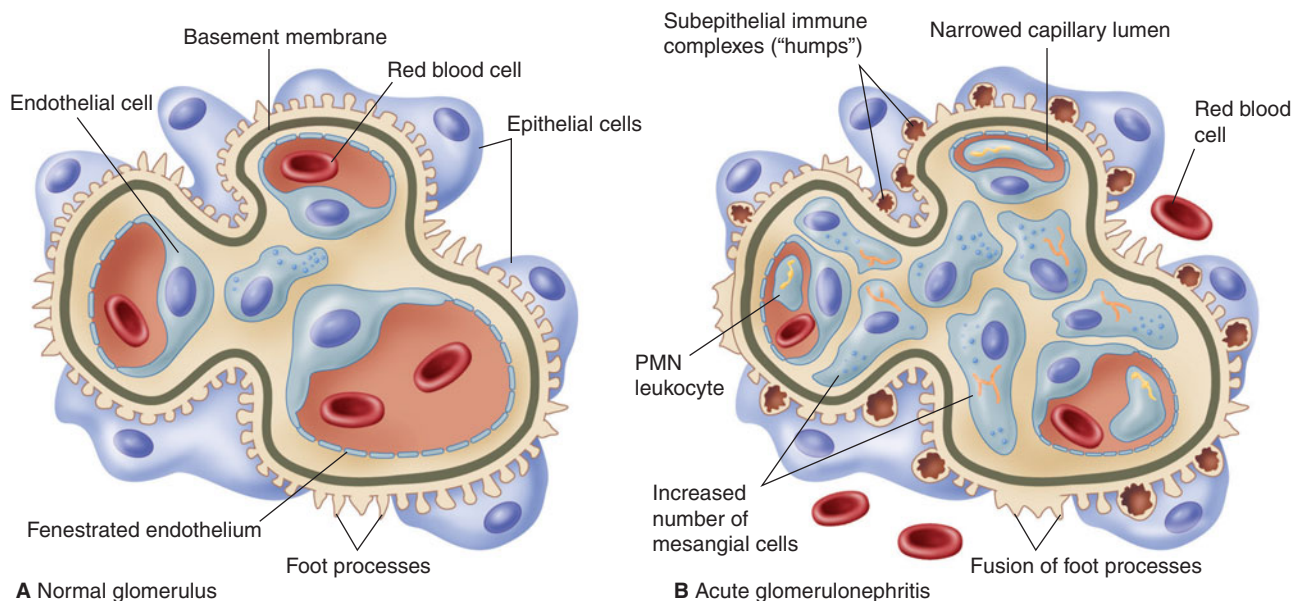


Figure 10-5 ► (A) Normal glomerulus and (B) acute glomerulonephritis.

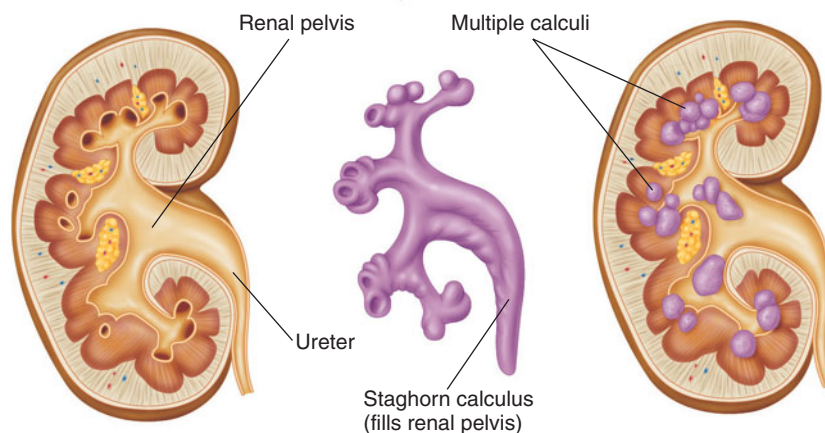


Figure 10-6 ► Urinary calculi.

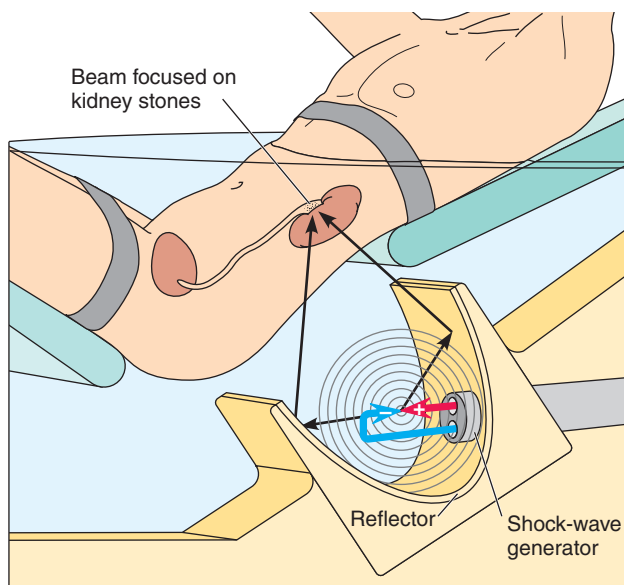
crush the stones. If performed while the patient is immersed in a tank of water, the procedure is called **hydrolithotripsy** (Figure 10-7 ►). In this technique, the partially submerged patient is subjected to the sonic waves that shatter the hard stones into sand-sized particles that can be eliminated with the urine. Recovery is rapid,

but there may be some bruising, and the patient might require a hospital stay.

Prognosis is good, although recurrence of stones is not uncommon. To prevent recurrence, fluid intake should be increased to keep the urine dilute, and dietary calcium and protein should be reduced.



A



B

Figure 10-7 ► Extracorporeal shock-wave lithotripsy. Acoustic shock waves generated by the shock-wave generator travel through soft tissue to shatter the renal stone into fragments, which are then eliminated in the urine. (A) A shock-wave generator that does not require water immersion. (B) An illustration of a water immersion lithotripsy procedure.

Promote Your Health

Stay Hydrated

A simple way to promote urinary system health is to stay hydrated. If you are well hydrated, your kidneys will excrete extra water in the urine. As urine flows regularly, it flushes microorganisms from the bladder and urethra,

preventing UTIs. Good hydration also reduces the risk for the developing kidney and bladder stones. The best drink in most circumstances is plain water because it adds no salt, sugar, calories, or caffeine to the diet.

Chronic Diseases and Disorders

Renal Failure

Renal failure is the progressive loss of kidney function over time. Renal failure has many underlying causes, so its prevalence is not known. Risk factors include diabetes, glomerulonephritis, or other chronic kidney diseases. Ischemia, hemorrhage, shock, toxins, and large kidney stones or tumors may cause renal failure. In renal failure the kidneys are unable to clear the blood of urea and creatinine, which are nitrogen-containing waste products of protein metabolism. These metabolic products are toxic if they accumulate in the blood, a condition known as *uremia*. Uremia signifies the terminal stage of renal failure (Figure 10–8 ►).

Diagnostic tests include blood tests for blood urea nitrogen, and tests of the glomerular filtration rate (GFR). GFR determines the ability of the kidney to clear creatinine. When GFR is

impaired, the serum creatinine level rises and the creatinine clearance rate falls. Treatment depends on the underlying cause of renal failure but usually includes renal dialysis.

Chronic Kidney Disease

Chronic kidney disease is life-threatening and has a much poorer prognosis than acute kidney injury. The risk factors for chronic kidney disease include chronic glomerulonephritis, hypertension, and **diabetic nephropathy**, kidney disease resulting from diabetes mellitus. Chronic kidney disease is also related to long-term use of ibuprofen or aspirin. Here we discuss diseases associated with the development of chronic kidney disease.

Diabetic Nephropathy Today diabetic nephropathy is recognized as the most common cause of chronic kidney disease and end-stage renal disease in the United States. Diabetic nephropathy is due to inflammation of the glomerulus, which leaks high levels of albumin and other plasma

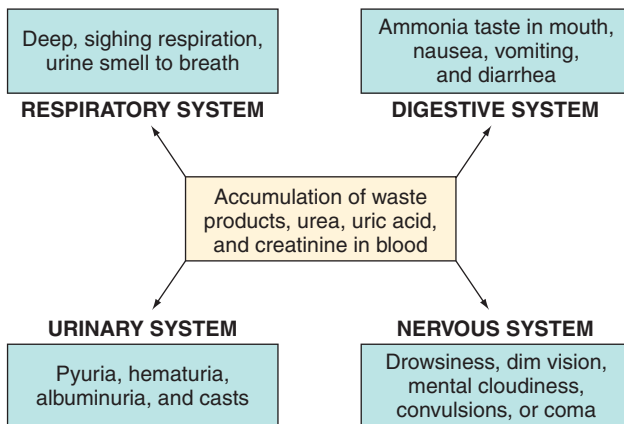


Figure 10–8 ► Manifestations of chronic renal failure.

Healthy Aging

Manage Diabetes Mellitus

After years of diabetes mellitus, mature adults have a risk for developing diabetic nephropathy. The best way to reduce the risk for diabetic nephropathy is to manage diabetes mellitus from the first day it is diagnosed. The kidney damage of diabetic nephropathy is cumulative and irreversible, so it is much better to prevent this disease than to deal with its consequences.

components into the urine. Diabetics are at risk for nephropathy if blood glucose and hypertension remain uncontrolled. Symptoms develop slowly over 5–10 years and include fatigue, headache, itching, frothy urine, frequent hiccups, and edema, particularly in the legs. A kidney biopsy confirms the diagnosis and determines the extent of the disease.

Hypertensive Kidney Disease Hypertensive kidney disease is caused by kidney injury. Also called *renovascular hypertension*, hypertensive kidney disease is found in about 1 in 10 people with systemic hypertension. Hypertensive kidney disease occurs mainly in people over age 50.

Hypertensive kidney disease is caused by atherosclerosis of renal arteries and their small branches within the kidneys. As these vessels narrow, systemic blood pressure increases. The decreased blood to kidneys causes them to release renin, which converts the plasma protein angiotensin into angiotensin I. In the liver and lungs, angiotensin I is converted to angiotensin II, which triggers vasoconstriction and aldosterone secretion, resulting in hypertension.

Signs and symptoms include typical features of systemic hypertension, such as headache, heart palpitations and tachycardia (rapid heart rate), light-headedness, and anxiety. Damage to the retina can be observed. Sustained hypertension elevates the risk for heart failure, myocardial infarction, and stroke.

Diagnosis begins with a patient history. Because surgery might be able to help, the kidneys are examined to determine which kidney is affected and where the problems lie. Ultrasound and renal arteriography permit visualization of blood flow and obstruction. The blood in the renal veins can be tested for elevated renin to determine which kidney is affected.

Treatment includes surgery to correct the underlying renal vascular problems. The surgery can include renal artery bypass, endarterectomy, or angioplasty. Symptoms can be managed with antihypertension medication and diuretics and by controlling sodium intake. Renal hypertension may not be easily prevented, but the risk can be lowered by regular exercise, a low-fat diet, not smoking, and by treating hypertension, all of which help prevent atherosclerosis.

Nephrotic Syndrome Nephrotic syndrome (NS) is a chronic disease with proteinuria, hypoalbuminemia (low plasma albumin), hyperlipidemia (high plasma lipids), and edema. NS occurs in several forms that affect different populations and differ somewhat in signs, symptoms, and prognosis. Nephrotic syndrome results from glomerular injury that occurs in the course of other kidney diseases. Most cases of NS are due to glomerulonephritis and diabetes.

A chief sign of NS is edema of the ankles and around the eyes, and pleural and genital edema. Symptoms include low blood pressure, lethargy, and anorexia. High lipid levels can lead to premature atherosclerosis and associated complications. NS also raises the risk for infection and blood clots.

Diagnosis involves urinalysis that shows high protein levels and casts. Blood tests show high lipids and low albumin. A kidney biopsy may be performed to determine the presence of lesions characteristic of NS.

Treatment of NS requires addressing the underlying cause. NS can be treated with hypertension medications, diuretics, immune-suppressants, cholesterol-lowering drugs, and blood-thinning medications. The prognosis varies and depends on the form of NS. NS cannot be prevented, but the risk can be reduced by treating diabetes or glomerulonephritis.

Treatment of Chronic Kidney Disease Chronic kidney disease is treated with antihypertensives, diuretics, and kidney dialysis. Controlling weight, blood lipids, sodium intake, sugar levels, and engaging in regular exercise may help control progression of renal disease.

Renal dialysis is commonly used to treat renal failure before considering kidney transplant. Renal dialysis removes toxic substances from the blood. In **hemodialysis**, blood is removed from the body and passed through dialysis membranes where toxic substances are removed from the blood, and the blood is returned to the body (Figure 10–9 ►). For hemodialysis, a patient typically must visit a clinic or hospital for dialysis treatment and stay for 3–6 hours during the process. However, residential dialysis units allow patients more convenient and private treatment. Small portable dialysis units have further reduced cost and have increased availability for many patients.

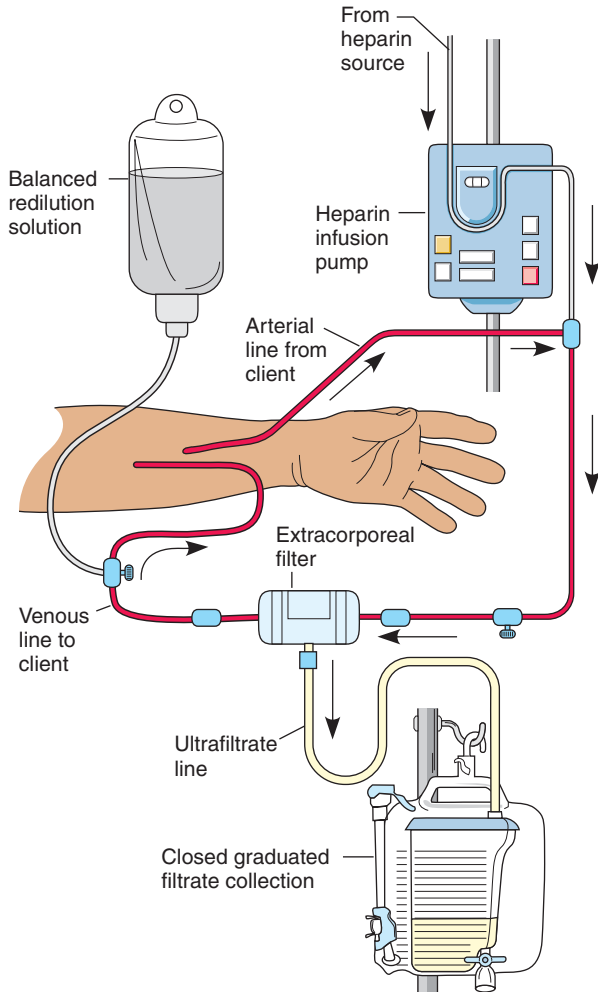


Figure 10-9 ► Hemodialysis.

In **peritoneal dialysis (PD)**, dialyzing fluid is introduced into the abdominal cavity, where the peritoneum or cavity lining acts as a dialysis filter membrane. The fluid draws toxic materials out of capillaries surrounding the body cavity, and after a suitable amount of time, the peritoneal fluid is removed, along with its dissolved toxins. A bag may be attached externally to collect the fluid, permitting the patient to remain mobile and providing more freedom and flexibility during treatment. Dialysis may be required for years but may not be sufficient in advanced chronic kidney disease.

Kidney function can decline to a point that dialysis is no longer an effective treatment option. A kidney transplant may be viable for some of these people. One transplanted kidney

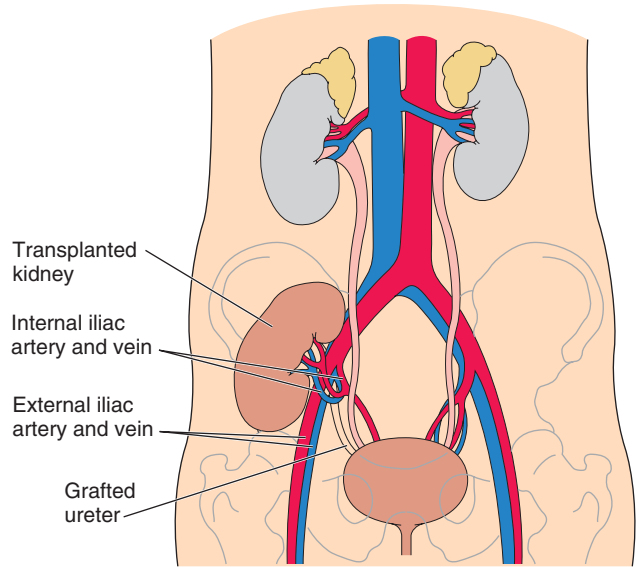


Figure 10-10 ► Placement of a transplanted kidney.

can replace the function of two nonfunctional kidneys, but the procedure is not for everyone. The candidate must be healthy enough to endure the risks of surgery, a long recovery, and a lifetime of antirejection drugs. Available tissue-matched kidneys are uncommon, and long wait lists have developed, resulting in waiting a year or more before a potential donor kidney is identified. Kidneys can be transplanted by living donors or from deceased donors. In either case, the transplant requires antirejection drugs for life. Partly because of such drugs, about 90% of live kidney recipients survive at least 5 years after the transplant (Figure 10-10 ►).

End-Stage Renal Disease

End-stage renal disease (ESRD) is a complete failure of kidney functioning and ends in death. ESRD follows the final stages of chronic kidney disease when dialysis or kidney transplantation have not succeeded. The risk for ESRD can be reduced by taking the following measures.

1. Control blood pressure and blood sugar levels.
2. If diabetic or hypertensive, monitor total urine protein levels.
3. If at high risk for ESRD, reduce dietary protein.
4. Do not smoke.

Prevention PLUS!

Chronic Kidney Disease

Chronic kidney disease is life-threatening and potentially preventable. A number of lifestyle choices reduce the risk for developing CKD. Notice that these behaviors reduce the risk for atherosclerosis and heart disease.

- Do not smoke.
- Reduce or eliminate alcohol use.
- Control weight.
- Reduce dietary fat, sodium, and sugar.
- Control blood pressure.
- Control diabetes.

Think Critically

1. How does atherosclerosis contribute to kidney disease?
2. Why do dietary factors affect kidney health?

Other Chronic Kidney Disorders

Hydronephrosis Hydronephrosis is a condition of urine retention within dilated kidney tubules. Hydronephrosis occurs in about 1 of 100 individuals, primarily affecting one kidney (Figure 10–11 ►). This condition results from urinary

calculi, a congenital defect, a tumor, an enlarged prostate gland, or other obstruction of the renal pelvis or ureter. The ureters may also dilate above an obstruction in a condition called **hydroureters** (Figure 10–12 ►). Signs and symptoms include hematuria and pain. Pyuria and fever occur if an infection develops because of reduced urine flow.

Hydronephrosis is diagnosed with physical exam, CT, or ultrasound. Treatment includes antibiotics, analgesics, catheterization, and surgery. Prevention is not possible, but risk can be reduced by treating stones or tumors that obstruct urine flow.

Chronic Glomerulonephritis Chronic glomerulonephritis (GN) is a slowly progressing inflammation of the glomeruli that leads to glomerular necrosis, chronic kidney disease, and renal failure. Chronic GN is caused by a number of different chronic kidney and glomerular diseases, systemic lupus erythematosus, renal autoimmunity, and hemolytic uremic syndrome. Signs and symptoms develop gradually, eventually lead to nephrotic syndrome, and include typical features of chronic kidney disease and renal failure. Diagnosis is based on history, urinalysis, blood urea nitrogen, and serum creatinine levels. Ultrasound or CT reveals small kidneys and

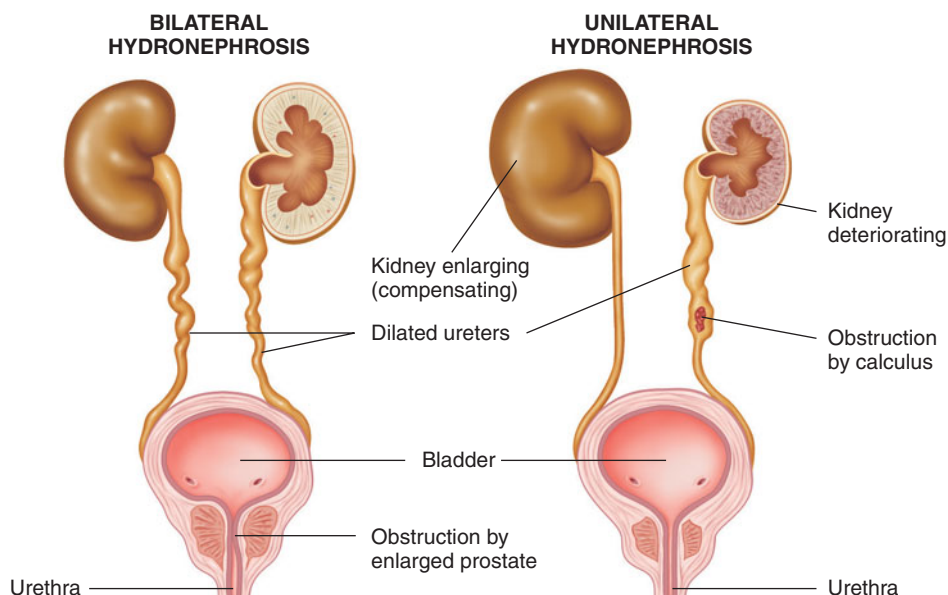


Figure 10–11 ► Hydronephrosis: bilateral (left), unilateral (right).

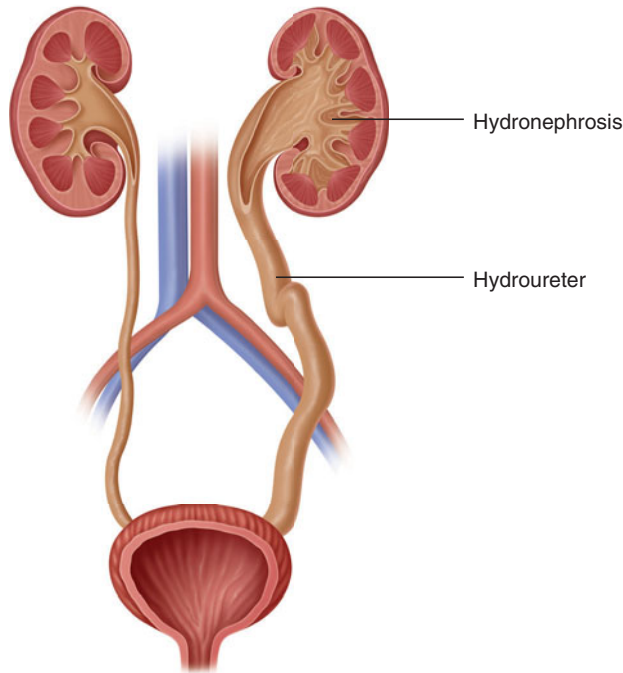


Figure 10–12 ► Hydroureter (Courtesy of Dr. David R. Duffell)

biopsy shows characteristic glomerular damage. Chronic GN is usually irreversible and symptoms are treated with antihypertensive medicine, a low-sodium diet, diuretic, and dialysis or transplantation. It may not be possible to prevent chronic GN, but the risk can be reduced by treating renal diseases and hypertension.

Urinary Incontinence Urinary incontinence is a common disorder characterized by the loss of bladder control to varying degrees. The prevalence of incontinence increases with age, although its precise prevalence remains unknown. In addition to age, risk factors include being female, being overweight, smoking, and prostatitis. Urinary incontinence is best thought of as a sign caused by underlying disease or habits. Temporary incontinence can be caused by alcohol, caffeine, excess fluid intake, and medications. Urinary tract infections and constipation can irritate the bladder, causing it to expel urine. Continuing urinary incontinence is associated with pregnancy and childbirth, bladder inflammation, infection, cancer, kidney stones, and prostatitis or prostate cancer. Neurologic

diseases, tumors, and spinal injuries also cause incontinence.

Signs and symptoms range from small leaks of urine—“dribbles”—to complete loss of control over urine flow. Stress incontinence is unexpected flow of urine that occurs with coughing, sneezing, laughing, or lifting. Others experience a sense of urinary urgency followed by flow of urine. Others experience overflow incontinence, in which the inability to empty the bladder results in continued leaking following urination.

Diagnosis requires a history, physical exam, and laboratory blood tests. Patients may be asked to maintain a diary of their incontinence to help identify associated patterns and triggers. Ultrasound and cystoscopy may be used to inspect the bladder.

Treatment depends on the type of incontinence and the nature of underlying causes. Treatments may involve behavioral changes, pelvic exercises, medication, catheterization surgery, or other interventions. Prevention requires treatment of the underlying diseases and disorders.

Malignancies

Renal Cell Carcinoma Renal cell carcinoma is a relatively rare type of cancer, comprising only 3% of all adult cancers. The prevalence of kidney cancer in men is twice that for women, and it normally occurs between ages 50 and 60. Smokers are twice as likely as nonsmokers to develop kidney cancer. The American Cancer Society projected nearly 65,000 new cases of kidney cancer in 2012. Major risk factors are smoking, obesity, and heredity.

The tumor grows slowly for several years. Painless hematuria eventually becomes the chief sign. When the tumor becomes large, an abdominal mass may be felt. This mass can then be detected on an x-ray as a tumor of the kidney. The malignancy frequently spreads to the lungs, liver, bones, and brain. Metastasis to other organs often occurs before the presence of the kidney tumor is known.

Besides pain, typical signs include loss of appetite, weight loss, anemia, and an elevated white blood cell count or leukocytosis. Surgical removal of the kidney or the tumor is an effective treatment.

Wilms' Tumor Wilms' tumor is a malignant tumor of the kidney pelvis that develops in children, usually diagnosed between ages 2 and 5. A fast-growing adenosarcoma, it metastasizes through the blood and lymph vessels. Symptoms and signs include hematuria, pain, vomiting, and hypertension similar to symptoms of renal carcinoma in an adult.

Wilms' tumor, found 1 in 10,000 individuals, has a genetic basis. At least three different genes influence the occurrence of this disease. The Wilms' tumor gene 1 (WT-1) has been identified as an important genetic marker for Wilms' tumor. When this gene is missing or mutated, congenital defects appear, and this abnormal tissue later becomes the site of cancer.

Diagnosis is done by CT and ultrasound and confirmed by kidney biopsy. Early diagnosis and treatment have improved the prognosis for Wilms' tumor. Prevention is not possible.

Carcinoma of the Bladder Carcinoma of the bladder is a malignant tumor originating in the urinary bladder. Bladder cancer accounts for more than 3% of cancers in men and more than 1% of cancer cases for women in the United States. Smokers have a risk 2½ times higher than non-smokers for developing bladder cancer. Symptoms are bleeding, burning pain, cramping, and

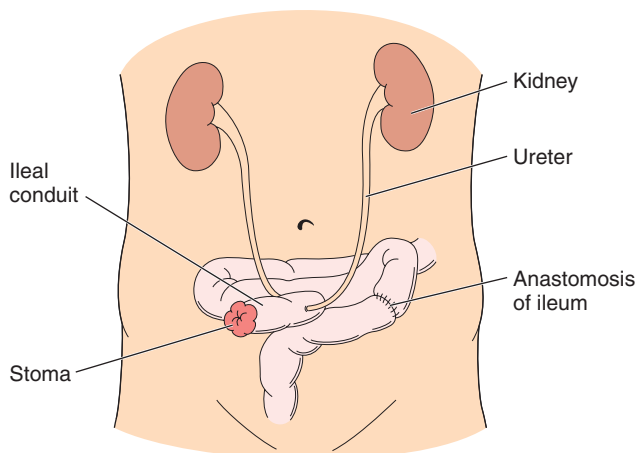


Figure 10-13 ► Ileal conduit. A segment of ileum is separated from the small intestine and formed into a tubular pouch, with the open end brought to the skin surface to form a stoma. The ureters are connected to the pouch.

inability to urinate. Diagnosis is done through physical exam, urinalysis procedures, biopsy, and blood analysis. The carcinoma can be detected with a **cystoscope** and removed surgically. If the urinary bladder must be surgically removed, an ileal conduit (Figure 10-13 ►) may be constructed surgically to store and evacuate urine. Prevention is not possible.

SIDE by SIDE

Polycystic Kidney



A

Normal kidney. (© Logical Images/Custom Medical Stock Photo)



B

Polycystic kidney. (Courtesy of the Centers for Disease Control and Prevention/Dr. Edwin P. Ewing, Jr., 1972)

Congenital Disorders

Polycystic Kidney Disease

Polycystic kidney disease (PKD) is the development of numerous fluid-filled pockets of tissue within the kidney. Cysts may also form in other organs such as the liver. Two genetic forms of PKD occur. About 90% of cases are autosomal dominant and affect adults. The autosomal recessive form affects children. In the United States about 600,000 individuals have PKD.

Signs and symptoms arise as the cysts fuse and enlarge, compressing surrounding tissue and impairing kidney function. Cysts may number in the hundreds or thousands, and they can cause the kidney to weigh 20–30 pounds. The accompanying *Side by Side* illustrates the polycystic kidney of an adult. Chief problems are pain, hypertension, and hematuria. PKD is diagnosed with a combination of a physical exam and a renal ultrasound or CT.

There is no cure for PKD. Treatment is aimed at controlling high blood pressure, pain, and infections that tend to arise in cysts. Surgery may be used to drain cysts, which can relieve pain temporarily. Eventually dialysis and kidney transplant may be needed. Prevention is not possible because of the genetic nature of PKD.

Other Congenital Disorders

Medullary Sponge Kidney Medullary sponge kidney is named for the appearance of the inner part (medulla) of an affected kidney. Affecting about 1 in 5,000–20,000 people in the United States, medullary sponge kidney is present at birth, but is usually asymptomatic until adulthood. In most cases, signs and symptoms include recurrent kidney stones, sometimes accompanied by hematuria, and pain. It can be diagnosed with ultrasound or intravenous pyelogram. No specific treatment is available, except for increasing fluids to reduce risks of forming stones and their complications. Medullary sponge kidney cannot be prevented, but its complications can be managed by reducing risks for kidney stones.

Congenital Disorders of the Ureters, Urinary Bladder, and Urethra Congenital abnormalities of the ureters, bladder, and urethra are relatively common, occurring in about 5% of births. Many of these disorders are immediately detected, whereas others are found when signs and symptoms arise later. Ureter disorders include duplication, abnormal position, abnormal location of openings, abnormal dilation, or constrictions. Urinary bladder abnormalities include a malformed wall or pouches. Congenital abnormalities of the urethra include epispadias, in which the urethral opening develops on the dorsal side of the penis, and hypospadias, in which the urethral opening occurs on the ventral surface of the penis. Many of these can be detected through assessment of urinary function at birth. Most require surgical repair to obtain normal function.

Age-Related Diseases

Several changes accompany the aging urinary system. With age comes less control over urination as urethral sphincter muscles lose tone.

The total number of functioning nephron units declines with age. As much as 30–40% of the nephrons may degenerate between ages 25 and 85. In addition, the kidney loses sensitivity to ADH. Reduction of rennin, and therefore aldosterone activity, causes a lack of salt and water retention, allowing more urine to be released by the kidney.

Urinary retention may also occur because the urinary bladder loses muscle tone and cannot empty completely. Obstruction exacerbates urine retention and is common in men because of prostate enlargement. Urinary retention, in turn, increases the risk for urinary tract infections and stone development. Kidney cancer increases significantly after age 60, and the incidence of bladder cancer increases after age 70.

Resource

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC): www.kidney.niddk.nih.gov

Diseases at a Glance

Urinary System

Disease	Etiology	Signs and Symptoms
Acute diseases		
Acute kidney injury	Shock, tubular necrosis, toxins, and medicines	Sudden oliguria or anuria, headache, drowsiness, seizure, coma
Pyelonephritis	Pyogenic bacteria	Pyuria, chills, high fever, sudden back pain, dysuria, hematuria, eventual renal failure, uremia
Urethritis and cystitis	Usually bacterial infection	Urinary frequency, urgency, burning sensation during urination, blood in urine
Lupus nephritis	Inflammatory	Hematuria, hypertension, joint pain
IgA nephropathy	Inflammatory, autoimmune	Hematuria, edema
Acute post-streptococcal glomerulonephritis	Inflammatory, autoimmune reaction after streptococcal infection	Chills, fever, loss of appetite, weakness, edema, albuminuria, hematuria, casts
Urinary calculi (kidney stones)	Urinary stasis, genetic factors	Pain, hematuria, nausea, vomiting, urinary tract infections
Chronic kidney diseases		
Diabetic nephropathy	Diabetes-associated hypertension and high blood glucose	Fatigue, headache, itching, frothy urine, hiccups, edema
Hypertensive kidney disease	Atherosclerosis of renal arteries	Headache, heart palpitations, tachycardia, light-headedness, anxiety
Nephrotic syndrome	Chronic glomerulonephritis, diabetes	Edema, anorexia, low blood pressure, high blood lipids
Chronic glomerulonephritis	Glomerular inflammatory conditions, untreated acute kidney injuries, hemolytic uremic syndrome, lupus	Hypertension, uremia

Diagnosis	Treatment	Prevention
Patient history, blood tests, and urinalysis	Restricted sodium and protein diet, restrict fluid intake, dialysis for hyperkalemia	Treat kidney diseases and avoid kidney toxins
Urinalysis, pus and blood in urine	Antibiotics	Treat lower urinary tract infections and kidney stones
Microscopic exam of urine, patient history	Antibiotics	Maintain regular urination habits, good hygiene
Patient history, urinalysis, blood tests, kidney biopsy	Anti-inflammatories, immune-suppressants, antihypertensives, reduced salt and fat diet	Reduce risk by treating systemic lupus erythematosus
Blood tests, urinalysis, renal biopsy	None for mild cases; treat hypertension	None
Urinalysis, patient history	Anti-inflammatories, immune-suppressants, treat hypertension	Reduce risk by treating streptococcal infections
Patient history, blood and urinalysis, CT ultrasound	Lithotripsy, surgery	Prevent dehydration
Patient history, kidney biopsy	Antihypertensives, dialysis	Control diabetes
Patient history, ultrasound, renal arteriography, renin levels in renal veins	Endarterectomy, angioplasty, renal artery bypass, manage hypertension	Low lipid and sodium diet, not smoking, exercise
Patient history, urinalysis, blood analysis, kidney biopsy	Treat underlying disease, manage symptoms	Treat glomerulonephritis and diabetes
Urinalysis, blood tests, ultrasound, CT	Treat hypertension, dialysis, transplantation	Treat acute kidney injuries, lupus

Disease	Etiology	Signs and Symptoms
Hydronephrosis	Renal obstruction or congenital defect	Pain, hematuria
Urinary incontinence	Behavior, childbirth, pregnancy, aging, diet, neurologic damage	Urgency, dribbling urine, or complete lack of urine control
Congenital disorders		
Polycystic kidney	Genetic	Pain, hypertension, hematuria
Medullary sponge kidney	Congenital	Few; recurrent kidney stones, hematuria, pain
Congenital disorders of urinary bladder, ureters, and urethra	Various malformations apparent at birth or soon after	Various symptoms associated with malformed organs
Malignancies		
Renal cell carcinoma	Idiopathic, risk elevated for smokers	Painless hematuria, later pain, loss of appetite, weight loss, anemia, elevated white blood count
Wilms' tumor	Idiopathic, probably genetic	In young children, signs and symptoms similar to renal cell carcinoma in adults
Bladder cancer	Idiopathic, smoking, hazardous chemicals	Hematuria, dysuria, fatigue, anorexia

Diagnosis	Treatment	Prevention
Urinalysis, CT, ultrasound	Analgesics, catheterization surgery	Treat or prevent kidney stones
Patient history, cystoscopy	Behavior and diet modification, pelvic exercise, surgery	Reduce risk factors when possible
Ultrasound, CT	Treat symptoms, transplantation	None
Patient history, ultrasound, CT	Treat symptoms, hydration	None
Physical exam, ultrasound	Surgery	
CT, ultrasound	Surgery	Uncertain
CT, ultrasound	Surgery, sometimes radiation	None
Cystoscope, biopsy, CT	Radiation, surgery	Uncertain; do not smoke

Interactive Exercises

Cases for Critical Thinking

1. Jane, a college sophomore, experienced painful urination and noticed blood in the urine. What can explain her symptoms and hematuria?
2. Britany, a thin fourth grader, experienced a significant weight gain within 2 weeks' time. Just before holiday break, she had a bad sore throat, but after a visit to the doctor, those symptoms subsided. Her abdomen was distended and she had edema of the extremities. She complained of abdominal discomfort and general aches. Urinalysis indicated proteinuria and hematuria. A follow-up blood screen found antibodies to streptococci. What may explain Britany's symptoms?
3. A mother of a 4-month-old infant, while giving a bath, noticed and palpated a mass on the right side of the child's abdomen. The child was irritable and somewhat lethargic. What might explain this mass, and what diagnostic techniques can help determine the nature of the disease?
4. A 52-year-old grandfather's urinalysis revealed blood (hematuria). The x-ray showed a renal mass on the right side. What is the probable cause for the hematuria, and what treatment would be recommended?

Multiple Choice

1. Which describes anuria?
 - a. blood in the urine
 - b. uncontrolled passage of urine
 - c. painful urination
 - d. complete lack of urine production
2. Which condition is an inflammatory disease of the kidney?
 - a. pyelonephritis
 - b. polycystic kidney disease
 - c. hydronephrosis
 - d. hypertensive kidney disease
3. Which inflammatory disease occurs 1–4 weeks following a streptococcal infection?
 - a. nephrotic syndrome
 - b. acute glomerulonephritis
 - c. cystitis
 - d. polycystic kidney
4. Which term describes high levels of ammonia in the blood?
 - a. glomerulonephritis
 - b. pyelonephritis
 - c. tuberculosis
 - d. uremia
5. Which of the following is true about urinary tract infections?
 - a. more common in males
 - b. symptoms include dysuria and urgency
 - c. commonly caused by a virus
 - d. do not respond to antibiotics
6. Which form of kidney dialysis permits a patient to retain mobility?
 - a. peritoneal dialysis
 - b. hemodialysis
 - c. hemolysis
 - d. ileal shunt
7. Painful urination is described as
 - a. micturition
 - b. dysuria
 - c. anuria
 - d. hematuria
8. What is a common cause of chronic kidney disease?
 - a. diabetic nephropathy
 - b. bacterial infection
 - c. autoimmune disease
 - d. kidney stones

9. What causes hypertensive kidney disease?
 - a. bacterial infection
 - b. hyperalbuminuria
 - c. renal artery atherosclerosis
 - d. lower GFR
10. Bacteria cause all of the following *except*:
 - a. pyelonephritis
 - b. cystitis
 - c. urethritis
 - d. chronic glomerulonephritis

True or False

- | | |
|---|--|
| <p>_____ 1. A sudden drop in urine volume indicates acute kidney disease.</p> <p>_____ 2. Cystitis is often caused by bacteria.</p> <p>_____ 3. Kidney stones usually do not recur after treatment.</p> <p>_____ 4. Albuminuria is a condition of low protein in the urine.</p> <p>_____ 5. Wilms' tumor occurs mainly in adults.</p> | <p>_____ 6. Bacteria do not cause acute glomerulonephritis</p> <p>_____ 7. Pyelonephritis is a pus-forming bacterial infection.</p> <p>_____ 8. Diabetic nephropathy is a common cause of chronic kidney disease.</p> <p>_____ 9. Leukocytes in urine indicate bacterial infection.</p> <p>_____ 10. Kidneys help regulate blood pressure.</p> |
|---|--|

Fill-Ins

- | | |
|---|--|
| <p>1. _____ is pus in the urine.</p> <p>2. _____ is a kidney disease resulting from diabetes mellitus.</p> <p>3. Urinary calculi, or _____, may be present and cause no symptoms until they become lodged in the ureter.</p> <p>4. _____, the external crushing of kidney stones, is now the preferable procedure to remove kidney stones, replacing the need for surgery.</p> <p>5. _____ is a congenital anomaly with cysts that usually involves both kidneys.</p> | <p>6. Scanty urine or _____ is low urine volume (or formation).</p> <p>7. Uncontrolled passage of urine is called _____.</p> <p>8. Retention of urine within dilated ureters is known as _____.</p> <p>9. In adults, polycystic kidney is a genetic disease caused specifically by an autosomal _____ gene.</p> <p>10. _____ describes the presence of blood in urine.</p> |
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Chapter 11

Diseases and Disorders of the Reproductive System

Learning Objectives

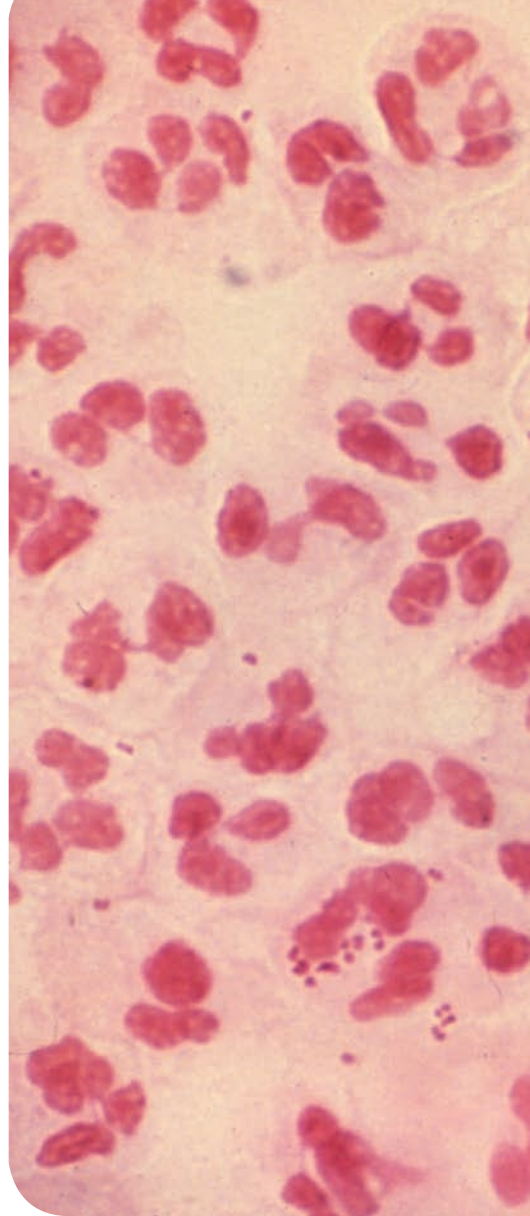
After studying this chapter, you should be able to

- Describe the normal structure and function of the reproductive system
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for diseases and disorders of the reproductive system
- Describe disorders of pregnancy
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for sexually transmitted infections (STIs)
- Describe the prevalence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for age-related diseases of the reproductive system

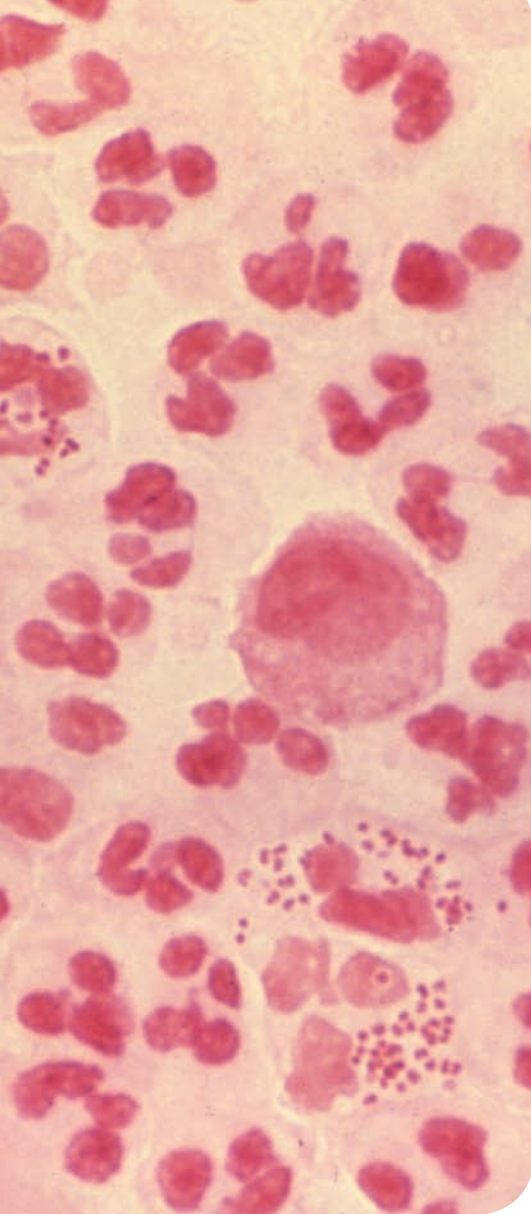
Fact or Fiction?

Latex condoms do not block the transmission of all sexually transmitted pathogens because the latex has microscopic holes that some pathogens can pass through.

Fiction: According to the Centers for Disease Control and Prevention (CDC), laboratory studies have shown that latex condoms provide an effective barrier against even the smallest sexually transmitted pathogens.



N. gonorrhoeae gonococci (inside leukocytes) from a patient diagnosed with acute gonococcal urethritis. (Courtesy of the Centers for Disease Control and Prevention/Joe Miller, 1979)



Disease Chronicle

Cervical Cancer

Cervical cancer has been known since ancient times. In 400 B.C.E., the Greek physician Hippocrates described and attempted to treat cervical cancer. For centuries the cause of cervical cancer remained unknown. In the 1840s tight corsets were blamed for the cancer. During the 1940s and 1950s physicians proposed that smegma, a thick, sebaceous gland secretion beneath the foreskin, caused cervical cancer. A breakthrough came in the 1960s and 1970s when microbiologists suspected that a virus caused the cancer, but they mistakenly identified it as herpes simplex virus. In the 1980s Dr. Harald zur Hausen concluded that the human papillomavirus is the etiological agent of most cervical cancers. In a major public health achievement, the vaccine Gardasil® was approved in 2006 by the U.S. Food and Drug Administration. Gardasil protects against four types of the human papillomavirus.

Anatomy and Physiology of the Female Reproductive System

The female reproductive system produces ova (eggs) and carries, nourishes, and gives birth to a fetus. The external genitalia (vulva) include the **mons pubis**, labia, **clitoris**, urethral opening, **perineum**, and the **greater vestibular glands**. The mons pubis is a fat pad that covers the symphysis pubis (the joint formed by the union of the two pubic bones), which becomes covered with hair at puberty. The **labia majora**, or outer vaginal lips, enclose and protect other external reproductive organs. The **labia minora**, or inner vaginal lips, protect the vaginal and urethral openings. The clitoris is a tuft of erectile tissue whose function is sexual arousal and pleasure. The urethral opening is a small tubular structure that drains urine from the bladder. The perineum is the space between the rectal opening and the vaginal opening. The perineum aids in constricting the urinary, vaginal, and anal openings and helps support the pelvic contents. The greater vestibular glands (or Bartholin's glands) lie on either side of the vaginal entrance and produce a lubricating secretion during sexual intercourse.

The internal reproductive tract includes the ovaries, fallopian tubes, uterus, and vagina. The ovaries are two small almond-shaped structures located on each side of the uterus. The ovaries produce ova, estrogen, and progesterone. Women are born with a fixed number of immature ova housed inside thousands of ovarian follicles within the ovaries.

The fallopian tubes are about 4 inches long and extend from each side of the uterus. The fallopian tubes transport ova from the ovaries to the uterus; fringed projections at the outer ends, the **fimbriae**, propel the ova into the tube. The fallopian tubes are the site of fertilization of the ovum, which lives approximately 24 hours after ovulation.

The uterus is a hollow, pear-shaped organ located between the urinary bladder and the rectum. The major portion of the uterus is called the body; the **cervix** is the narrow portion of the uterus that protrudes into the vagina. The uterus contains an inner lining called the endometrium that is thickened by estrogen and progesterone. A fertilized egg implants into the

endometrium and resides there for the rest of its development. When the woman is not pregnant, the endometrial lining sloughs off (menstruation), causing vaginal bleeding about every 28 days in response to changes in levels of estrogen and progesterone.

The vagina is the thin-walled muscular tube about 6 inches long leading from the uterus to the external genitalia. It is located between the bladder and the rectum. The vagina provides the passageway for childbirth and menstrual flow and it receives the penis during sexual intercourse. Figure 11-1 ► and Figure 11-2 ► show the female reproductive system.

The breasts lie over the chest muscle. Each breast contains 15–20 lobules. Each lobule consists of tiny, saclike acini that secrete milk during lactation. Minute ducts drain the acini, merging to form larger ducts as they travel toward the nipple. A pigmented area called the areola encircles the nipple. Numerous sebaceous glands dot the surface of the areola. Sebum from these glands lubricates the areola, helping prevent dryness and cracking during breastfeeding.

Puberty is triggered by rising levels of gonadotropin-releasing hormone (GnRH). GnRH stimulates the anterior pituitary to secrete follicle-stimulating hormone (FSH) and luteinizing hormone (LH). FSH stimulates the development of ovarian follicles. Ovarian follicles secrete estrogen and progesterone. Estrogen is responsible for the changes that occur during puberty, including breast development; depositing fat beneath the skin of the hips, thighs, and buttocks; and the widening of the pelvis. Puberty tends to begin earlier in females than in males, at about age 9 or 10. The first sign of puberty in girls is breast development followed by growth of hair in the pubic and axillary (armpit) regions. At about age 12 the first menstrual period (**menarche**) arrives.

Beginning in adolescence and continuing until menopause, a woman's reproductive system undergoes cyclic changes called the reproductive cycle each month as it prepares for the possibility of pregnancy. The reproductive cycle averages 28 days and includes the ovarian cycle and the menstrual cycle. The ovarian and menstrual cycles are interrelated with activities in both cycles occurring simultaneously. FSH and LH

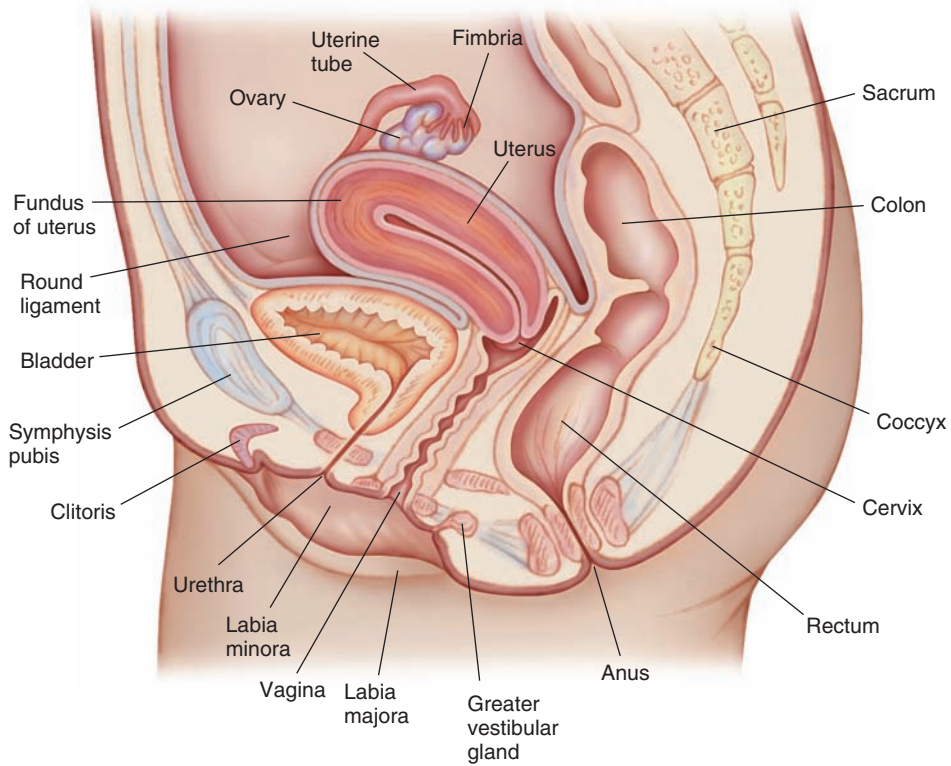


Figure 11-1 ► Sagittal section of the female pelvis, showing organs of the reproductive system.

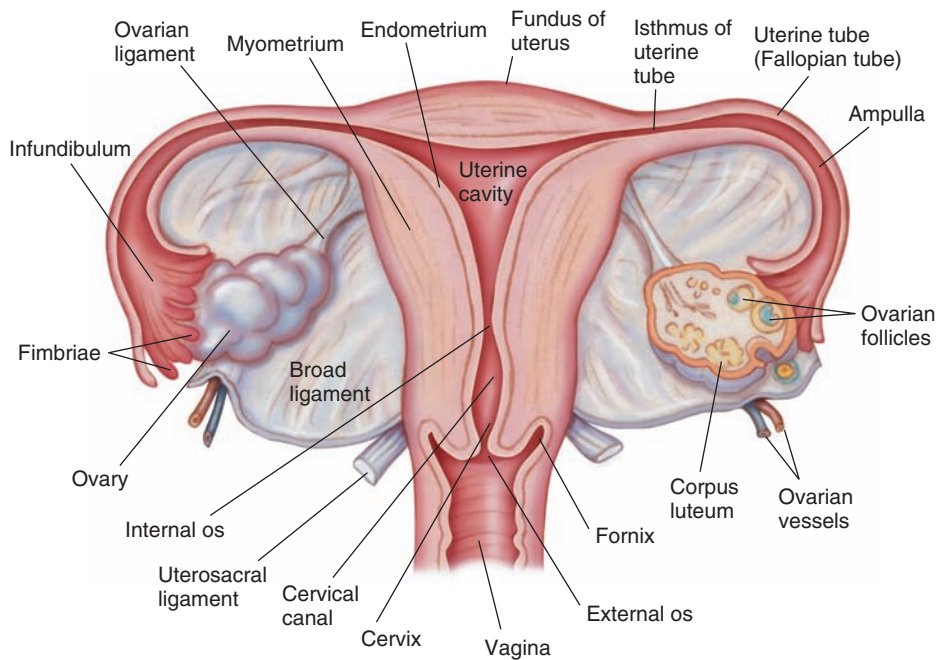


Figure 11-2 ► Internal female reproductive tract.

produced by the anterior pituitary gland drive the ovarian cycle. Estrogen and progesterone secreted by the ovaries drive the menstrual cycle.

The reproductive cycle begins on the first day of noticeable vaginal bleeding or menstruation. Menstruation usually lasts 3–5 days. The cycle begins as low levels of estrogen and progesterone trigger the hypothalamus to secrete GnRH. The GnRH then induces the anterior pituitary to secrete FSH and LH. FSH travels through the blood and stimulates the maturation of a single ovarian follicle. As the follicle matures it secretes estrogen and progesterone that promote thickening of the endometrium. Estrogen secreted by the ovaries also aids in thickening of the endometrium. As the follicle matures it migrates to the surface of the ovary. At the midpoint of the cycle, estrogen levels peak, triggering a surge in LH. The elevated LH causes the follicle to rupture and release the ovum in a process called ovulation. The fimbriae sweep the ovum into the fallopian tube. After ovulation, estrogen levels decline rapidly. Once the ovum has been released from the ovary, the empty follicle is converted into the **corpus luteum**, which secretes large amounts of progesterone. The progesterone causes the endometrium to thicken. If fertilization of the ovum does not occur, the corpus luteum degenerates. Estrogen and progesterone levels fall dramatically, causing the endometrium to slough off resulting in menstruation. Low levels of estrogen and progesterone cause the reproductive cycle to begin again.

Diagnostic Tests and Procedures

Physical examination of the female reproductive system begins with a pelvic examination. A pelvic examination can detect certain cancers in their early stages, infections, and other reproductive system disorders. This examination includes inspection of the external genitalia, visual examination of the vagina and cervix through a speculum (an instrument used to spread and hold the vaginal wall in an open position), and palpation of the female internal organs by bimanual examination. During a bimanual examination, the health care provider places one hand on the abdomen and inserts fingers of the other hand into the vagina to feel the female organs between

the two hands. A bimanual rectal examination allows palpation of the posterior aspect of the uterus and the rectum. During a pelvic examination, a sample for a Papanicolaou (Pap) test may be taken to look for changes in the cells of the cervix. CA 125 is a protein tumor marker that is found in greater concentrations in tumor cells than in other body cells and may be used for diagnosis of endometrial and ovarian cancer. In dilation and curettage (D&C), the cervix is widened (dilation) and part of the lining of the uterus is removed (curettage). D&C may be used in the diagnosis of endometrial cancer and treatment of menorrhagia.

Ultrasound permits visualization of the female reproductive system and can aid the diagnosis of **pelvic inflammatory disease (PID)**, benign breast conditions, uterine fibroid tumors, some cancers, **ectopic pregnancy**, and menstrual disorders. **Laparoscopy** is used to examine the female reproductive organs (Figure 11–3 ► and Figure 11–4 ►), **colposcopy** is used to visualize the cervix, and the uterine lining can be inspected with **hysteroscopy**. These visualization techniques can be used to diagnose some cancers, dysmenorrhea, and endometriosis. Mammography is an x-ray examination of breast tissue. If abnormalities or tumors are discovered, a biopsy may be performed. Imaging tests including x-rays, MRI, CT scan, and PET scan may be used to aid in staging cancers. Other laboratory tests that may be performed include urinalysis and blood tests (complete blood count, chemistry screen, and hormone testing).

Diseases of the Female Reproductive System

Pelvic Inflammatory Disease (PID)

The CDC estimates that each year in the United States 750,000 women experience an episode of acute PID. Although women of any age can develop PID, sexually active women under age 25 and those of childbearing age are at the greatest risk of acquiring the disease. Risk factors for PID include having multiple sex partners, having a sexually transmitted infection (STI), and being under age 25 and sexually active.

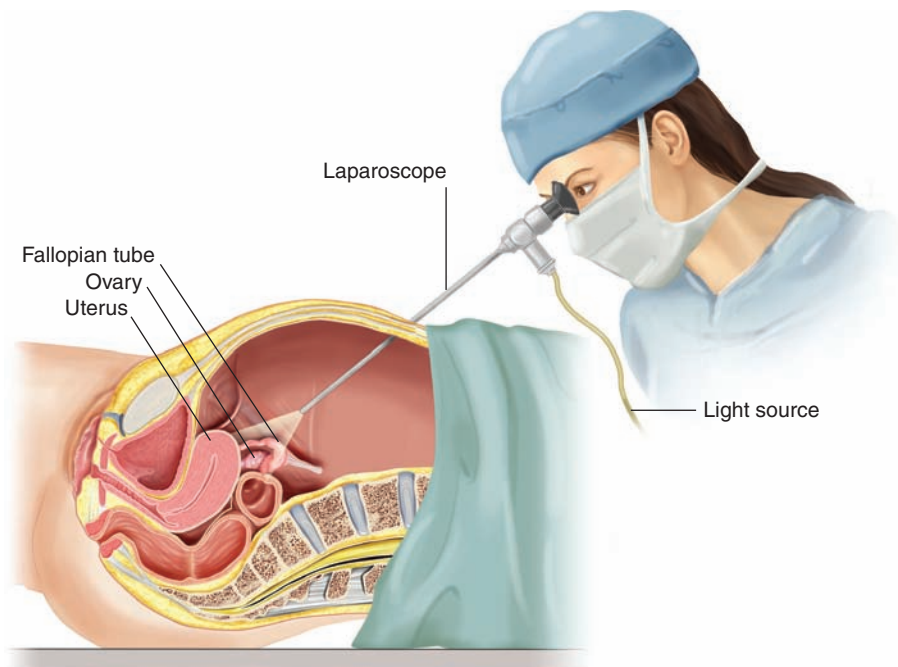


Figure 11-3 ▶ Laparoscopy. A laparoscope is used to view reproductive organs.

Signs and symptoms of PID vary from mild to severe. The most common PID symptom is lower abdominal pain, and other signs and symptoms include fever, unusual vaginal discharge with a foul odor, painful intercourse, painful urination, and irregular menstrual bleeding. PID is a serious complication of some STIs including gonorrhea and chlamydia.

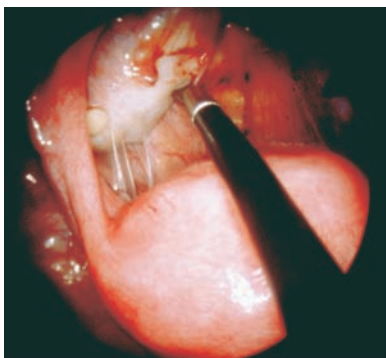


Figure 11-4 ▶ Photograph taken during a laparoscopic procedure. The uterus is visible below the probe, the ovary is at the tip of the probe, and the fallopian tube extends along the left side of the photo.

PID diagnosis may include physical examination, pelvic examination, STI testing, and ultrasound. The longer a woman delays treatment for PID, the more likely she will develop complications. Complications of PID include infertility, ectopic pregnancy, abscess formation, and chronic pelvic pain. PID is treated with antibiotics although antibiotic treatment does not reverse damage that has already occurred to the reproductive organs. Prevention of PID includes abstinence, monogamy, using latex condoms, and early diagnosis and treatment of STIs. The CDC recommends yearly chlamydia testing for all sexually active women age 25 and younger, older women with risk factors for chlamydial infections (those who have a new sex partner or multiple sex partners), and all pregnant women.

Cervical Cancer

Cervical cancer is a malignant neoplasm that forms within tissues of the cervix. The American Cancer Society (ACS) estimates that in 2013 approximately 12,340 cases of invasive cervical cancer will be diagnosed and 4,030 women will

die from cervical cancer in the United States. An estimated 528,000 women were diagnosed with cervical cancer and 266,000 died of cervical cancer worldwide in 2012. The average age of diagnosis is 48. The most important risk factor for cervical cancer is infection by the human papillomavirus (HPV). Women who smoke are about twice as likely as nonsmokers to get cervical cancer.

Women with early cervical cancers usually have no signs or symptoms until the cancer becomes invasive and grows into nearby tissue. When this happens, the most common signs and symptoms are abnormal vaginal bleeding, an unusual vaginal discharge, pelvic pain, and pain during intercourse. Most cervical cancer is caused by HPV, which is transmitted by sexual contact. There are many types of HPV, and approximately two-thirds of all cervical cancers are caused by HPV 16 and HPV 18. Some HPV strains cause genital warts (discussed later in this chapter), but other strains may not cause signs or symptoms.

Diagnosis of cervical cancer may include pelvic examination, Pap test, HPV DNA test, colposcopy, and cervical biopsy. Imaging tests may be used to aid in staging the cancer. The 5-year relative survival rate for localized cervical cancer is 91%, which suggests that women benefit from early diagnosis. The 5-year relative survival rate for all stages combined is 70%. Treatment for precancerous lesions may include cryosurgery (freezing), cauterization (burning), and laser surgery. Treatment for cervical cancer may include surgery, radiation therapy, and chemotherapy. Prevention of cervical cancer includes regular Pap tests to find precancers before they can turn into invasive cancer. The Pap test is an effective screen: between 60 and 80% of American women with newly diagnosed invasive cervical cancer had not had a Pap test in the past 5 years.

Cervical cancer screening information from the American Cancer Society, the U.S. Preventative Services Task Force (USPSTF), and the American College of Obstetricians and Gynecologists can be found at the CDC (www.cdc.gov/cancer/cervical/pdf/guidelines.pdf). The American Academy of Pediatrics recommends that all girls and boys between the ages of 11 and 12 receive

the three-dose vaccine for HPV; there are two HPV vaccines available. Both Gardasil® and Cervarix® offer protection against HPV 16 and HPV 18; Gardasil also offers protection against HPV 6 and HPV 11, which cause 90% of genital warts cases. Cervical cancer can be prevented via abstinence.

Endometrial Cancer

Endometrial cancer forms in the tissue lining the uterus. Other types of cancer can form in the uterus, but they are much less common than endometrial cancer. The ACS estimates that in 2013 there will be 49,560 new cases of cancer of the body of the uterus diagnosed in the United States and about 8,190 women will die from uterine cancer. The average age of diagnosis is 60. Because estrogen stimulates growth of the endometrium, the cumulative lifetime exposure to estrogen plays a role in many of the risk factors for endometrial cancer. Risk factors include abnormal overgrowth of the endometrium (endometrial hyperplasia), early puberty, late menopause, estrogen-only hormone replacement therapy, never having given birth, family history of uterine cancer or Lynch syndrome, and obesity.

Signs and symptoms may include vaginal bleeding after menopause, abnormal bleeding, abnormal vaginal discharge, pelvic pain, and pain during intercourse. The etiology of endometrial cancer is idiopathic. Most endometrial cancer cells possess receptors for estrogen, which stimulates tumor cells to divide.

Diagnosis requires a medical history, pelvic examination, hysteroscopy, removal of endometrial tissue (endometrial biopsy or D&C), complete blood count, and CA 125 blood test. Imaging tests may be used to aid in staging the cancer. Removing the cancer via surgery is the most common treatment for endometrial cancer. Treatment may also include radiation therapy and chemotherapy. The 5-year relative survival rate for endometrial cancer is about 83%; if the cancer is found at an early stage the 5-year survival rate is over 96%. Endometrial cancer cannot be prevented, but screening can identify early cancer.

Fibroid Tumors of the Uterus

Fibroid tumors (**leiomyomas**) are benign tumors of the smooth muscle of the uterus. Fibroid tumors are the most common tumors of the female reproductive system, affecting 20–40% of women age 35 and older. Uterine fibroid tumors usually develop after age 30 and shrink or disappear after menopause. The only known risk factor for developing uterine fibroid tumors is being a woman of reproductive age.

Signs and symptoms depend on the size and location of the fibroid tumors. Uterine fibroid tumors vary in size from a quarter of an inch to the size of a cantaloupe. Most women with uterine fibroid tumors are asymptomatic. When they do occur, signs and symptoms include excessive vaginal bleeding, pelvic pressure, abdominal pain, abdominal enlargement, and pain during intercourse. The etiology of uterine fibroid tumors is idiopathic.

Diagnosis requires pelvic examination and ultrasound. Treatment for uterine fibroid tumors depends on severity of signs and symptoms and childbearing plans. Watchful waiting may be an option if there are no signs and symptoms. Oral contraceptives may decrease the bleeding caused by uterine fibroid tumors. Uterine artery embolization shrinks uterine fibroids by cutting off their blood supply. Focused ultrasound surgery destroys uterine fibroid tumors using high-frequency sound waves. Endometrial ablation destroys the endometrium and reduces the amount of bleeding during menstruation. Myomectomy is the surgical removal of uterine fibroid tumors. One-third of hysterectomies performed in the United States are due to uterine fibroid tumors. Unfortunately, these common tumors cannot be prevented.

Ovarian Cancer

Ovarian cancer is a malignant neoplasm arising in tissues of the ovaries. The ACS estimates that in 2013 approximately 22,240 cases of ovarian cancer will be diagnosed and 14,230 women will die from ovarian cancer in the United States. The average age of diagnosis is 63. Risk factors for ovarian cancer include age, never having given

birth, and a personal or family history of ovarian, breast, or colorectal cancer.

Signs and symptoms may include bloating, pelvic or abdominal pain, trouble eating or feeling full quickly, and changes in urinary urgency or frequency. The etiology of ovarian cancer is idiopathic.

Currently there is no effective screening test for ovarian cancer. About 20% of ovarian cancers are found at an early stage, but most ovarian tumors are difficult to find early because the ovaries are deep in the pelvis, making it difficult for doctors to feel them during a pelvic examination. Confirmation of the mass can be made by CT or MRI scan or ultrasound. Laparoscopy, biopsy, and CA 125 blood test may be performed. Treatment options include surgery, radiation therapy, and chemotherapy. If detected early ovarian cancer has a 5-year survival rate of approximately 90%. Unfortunately, 80% of ovarian cancers are diagnosed at an advanced stage, when the 5-year survival rate is approximately 30%. With no effective screening and an unknown etiology, ovarian cancer remains unpreventable.

Breast Cancer

Breast cancer is a malignant tumor that forms in tissues, ducts, or glands of the breast. Breast cancer is found mostly in women, but men can get breast cancer. The ACS estimates that in 2013 approximately 232,340 cases of invasive breast will be diagnosed and 39,620 women will die from breast cancer in the United States. An estimated 1.67 million women were diagnosed with breast cancer and 522,000 died of breast cancer worldwide in 2012. Breast cancer affects women of all ages, although the average age of diagnosis is 61. Risk factors include age, never having given birth, having your first child after age 35, beginning menopause after age 55, genetic risk factors, being overweight or obese after menopause, lack of physical activity, drinking alcohol, breast density, being Caucasian, and family or personal history of breast cancer.

The most common sign of breast cancer is a lump or mass with irregular borders within the breast. Other signs and symptoms of breast

cancer may include swelling of all or part of the breast; skin irritation or dimpling; breast or nipple pain; nipple retraction; redness, scaliness, or thickening of the nipple or breast skin; and a nipple discharge other than breast milk. Approximately 5–10% of breast cancer cases are thought to be hereditary. Women who inherit a BRCA1 or BRCA2 mutation have a 50–85% chance of developing breast cancer by age 70. The etiology of the remaining breast cancers is idiopathic. Approximately 75% of breast cancer tumor cells have receptors for estrogen, progesterone, or both estrogen and progesterone. The hormone binding to its receptor stimulates the tumor cell to divide. In approximately 20–25% of breast cancers the tumor cells overexpress HER2, the receptor for human epidermal growth factor. Overexpression of HER2 causes cells to divide more rapidly than normal cells because human epidermal growth factor transmits signals directing cell growth.

Regular screening and early diagnosis are critical to identify and treat breast cancer. Starting in their 20s, women are strongly urged to examine their breasts monthly for signs of cancer. Women in their 20s and 30s should have a clinical breast examination (CBE) by a health professional every 3 years. After age 40, women

should have a CBE every year. Mammography can detect small, early cancers, and the ACS recommends that women age 50 and older have a yearly mammogram (Figure 11–5 ►). Ultrasound may be used to target specific areas of concern found on the mammogram. A biopsy of the suspected malignancy confirms the diagnosis or shows the tumor to be benign. Imaging tests may be used to aid in staging the cancer. Treatment of breast cancer may include surgery, radiation, chemotherapy, and targeted drug therapy (blocks the growth and spread of cancer by interfering with specific molecules involved in tumor growth and progression). Hormone therapy may be used to block estrogen receptors or inhibit estrogen production. The overall 5-year survival rate for breast cancer is about 90%, but varies with the stage of detection. Early detection remains critical because breast cancer cannot be prevented.

Benign Conditions of the Breast

Benign breast conditions are very common. Unlike breast cancer, benign breast conditions are not life-threatening. Three types of benign breast conditions—**fibroadenomas**, breast cysts, and fibrocystic breast changes—are discussed.

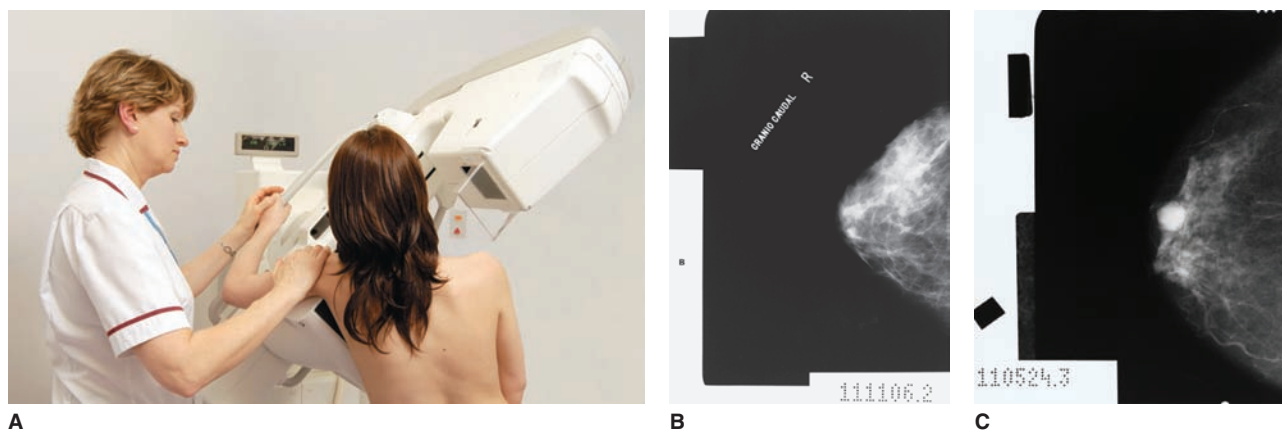


Figure 11–5 ► Mammograms. (A) Mammogram procedure. (B) Film of normal breast. (C) Film of breast with tumor.

Prevention PLUS!

Self-Screening for Breast Cancer

The Five Steps of a Breast Self-Examination

Starting in their 20s women should perform monthly breast self-examinations (BSE). If you still have menstrual periods, you should perform the examination a few days after your period has ended. If you are not menstruating BSE should be performed on the same day each month.

Step 1: Begin by looking at your breasts in the mirror with your shoulders straight and your arms on your hips.



Here's what you should look for:

- Breasts that are their usual size, shape, and color
- Breasts that are evenly shaped without visible distortion or swelling

If you see any of the following changes, bring them to your doctor's attention:

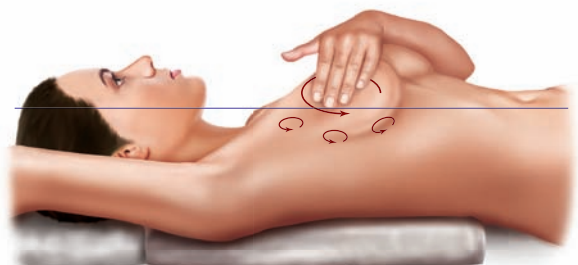
- Dimpling, puckering, or bulging of the skin
- A nipple that has changed position or an inverted nipple (pushed inward instead of sticking out)
- Redness, soreness, rash, or swelling

Step 2: Raise your arms and look for the same changes.



Step 3: While you're at the mirror, look for any signs of fluid coming out of one or both nipples (this could be a watery, milky, or yellow fluid or blood).

Step 4: Feel your breasts while lying down, using your right hand to feel your left breast and then your left hand to feel your right breast. Use a firm, smooth touch with the first few finger pads of your hand, keeping the fingers flat and together. Use a circular motion, about the size of a quarter.



Cover the entire breast from top to bottom, side to side—from your collarbone to the top of your abdomen, and from your armpit to your cleavage.

Follow a pattern to be sure that you cover the whole breast. You can begin at the nipple, moving in larger and larger circles until you reach the outer edge of the breast. You can also move your fingers up and down vertically, in rows, as if you were mowing a lawn. This up-and-down approach seems to work best for most women. Be sure to feel all the tissue from the front to the back of your breasts: for the skin and tissue just beneath, use light pressure; use medium pressure for tissue in the middle of your breasts; use firm pressure for the deep tissue in the back. When you've reached the deep tissue, you should be able to feel down to your ribcage.

Step 5: Feel your breasts while you are standing or sitting.

Many women find that the easiest way to feel their breasts is when their skin is wet and slippery, so they like to do this step in the shower. Cover your entire breast, using the same hand movements described in Step 4.

Think Critically

1. How often should a woman do a breast self-exam?
2. What is the difference between a breast self-exam and a clinical breast exam?



Source: www.breastcancer.org/symptoms/testing/types/self_exam/bse_steps

Fibroadenomas

Fibroadenomas are the most common benign tumor of the breast, affecting up to 10% of all women. Fibroadenomas are most common in women 15–30 years old and pregnant women. There are no known risk factors for fibroadenomas. Fibroadenomas are often felt during breast examination and feel firm, round, smooth, rubbery, are easily movable, and have clearly defined edges. A fibroadenoma may feel tender and may swell due to hormonal changes. The etiology of fibroadenomas is idiopathic. Diagnosis of fibroadenomas may include breast examination, mammogram, ultrasound, MRI, and fine needle biopsy. Fibroadenomas often stop growing or even shrink on their own without any treatment. Treatment may include removal of the fibroadenoma via surgery, laser ablation, or cryoablation. Fibroadenomas cannot be prevented.

Breast Cysts

Breast cysts are fluid-filled sacs within the breast tissue. Breast cysts feel like a soft grape or water-filled balloon, or they may be firm. Breast cysts are common, especially in women in their 30s and 40s, but the prevalence is not known. There are no known risk factors for developing breast cysts. Signs and symptoms of breast cysts include a smooth, easily movable round or oval breast lump with defined edges, breast pain or tenderness in the area of the cyst, and the cysts may vary in size during the menstrual cycle. The etiology of breast cysts is idiopathic. Diagnosis of breast cysts may include breast examination, mammogram, ultrasound, fine needle aspiration, and biopsy. Breast cysts do not require treatment unless the cyst is large and painful, and they disappear after menopause unless the patient is on hormone replacement therapy.

Treatment may include oral contraceptives to help reduce the recurrence of breast cysts. Fine needle aspiration can be used to drain fluid from breast cysts to confirm the diagnosis and relieve pain. Discontinuing hormone replacement therapy during the postmenopausal years may reduce the formation of cysts. Surgical removal of a breast cyst is rarely necessary. Breast cysts cannot be prevented.

Fibrocystic Breast Changes

Fibrocystic breast changes (FBC) is a common benign breast condition. FBC includes fibrosis (fibrous connective tissue becoming more prominent) and breast cyst formation. The prevalence of FBC is not known; more than half of all women may notice some FBC in their breasts over their lifetime. FBC are most common in women of child-bearing age, but they can affect women of any age. There are no known risk factors for FBC. Signs and symptoms of FBC may include breast swelling or thickening, lumps within the breasts that may vary in size and texture, and breast pain or tenderness. Signs and symptoms may change throughout the menstrual cycle or during pregnancy. The etiology of FBC is idiopathic. FBC may be diagnosed by breast examination, mammogram, ultrasound, fine needle aspiration, and biopsy. In most cases, treatment is not needed for FBC. Women with mild discomfort may benefit from wearing a supportive bra, taking over-the-counter pain relievers, and reduced intake of caffeine and stimulants found in coffee, tea, chocolate, and soft drinks. Oral contraceptives may help women with severe signs and symptoms. FBC cannot be prevented.

Menstrual Disorders

Menstrual Irregularities

Amenorrhea is the absence of menstrual periods. It is known as primary amenorrhea if menstruation fails to begin by age 16. Primary amenorrhea affects less than 1% of adolescent girls in the United States. Risk factors for amenorrhea include eating disorders, athletic training, and a family history of amenorrhea. The etiology of primary amenorrhea includes chromosomal

abnormalities, problems with the hypothalamus, pituitary disease, lack of reproductive organs, or structural abnormality of the vagina.

The cessation of menstrual periods for 3–6 months or more, once they have begun, is termed secondary amenorrhea. Each year in the United States approximately 5–7% of menstruating women experience 3 months of secondary amenorrhea. The etiology of secondary amenorrhea includes pregnancy, contraceptives, breastfeeding, stress, medication, chronic illness, hormone imbalance, low body weight, excessive exercise, thyroid disorders, pituitary tumor, uterine scarring, and premature menopause. Diagnosis requires medical history, pregnancy test, pelvic examination, blood test to check hormone levels, and progestin challenge test (giving progestin to see if it triggers menstruation).

Treatment, if any, depends on the cause of amenorrhea and may include lifestyle changes related to weight, physical activity, or stress level; amenorrhea caused by thyroid or pituitary disorders may be treated with medications. Prevention of amenorrhea includes maintaining a sensible exercise program, maintaining a healthy weight, eating a healthy diet, avoiding excessive alcohol consumption, not smoking, and finding healthy outlets for stress.

Dysmenorrhea is painful or difficult menses. Primary dysmenorrhea involves no physical abnormality and usually begins 6 months to a year after menstruation begins. Secondary dysmenorrhea involves an underlying physical cause, such as endometriosis or uterine fibroid tumors. Dysmenorrhea may affect more than half of menstruating women in the United States. Risk factors for dysmenorrhea include being under age 20, early-onset puberty, heavy bleeding during periods, irregular menstrual bleeding, never having given birth, family history of dysmenorrhea, and smoking. Symptoms of dysmenorrhea may include cramping and dull to severe pelvic and lower back pain that may radiate to other areas.

Prostaglandins are the cause of primary dysmenorrhea. The etiology of secondary dysmenorrhea includes PID, uterine fibroid tumors, and endometriosis. Diagnosis is made based on pelvic examination, ultrasound, laparoscopy, and hysteroscopy. Treatment may include

antibiotics, oral contraceptive therapy to regulate and decrease menstrual flow, taking over-the-counter pain relievers, and treatment of uterine fibroid tumors or endometriosis. Prevention of dysmenorrhea includes abstinence, monogamy, use of latex condoms, and obtaining early diagnosis and treatment of STIs.

Menorrhagia is excessive or prolonged bleeding during menstruation. Clinically, it is defined as total blood loss exceeding 80 mL per menses lasting longer than 7 days. Menorrhagia is one of the most common gynecologic complaints, affecting 30% of all premenopausal women. Nearly 30% of all hysterectomies performed in the United States are performed to alleviate heavy menstrual bleeding. Risk factors for menorrhagia include being an adolescent girl who has recently started menstruating and being an older woman approaching menopause. Signs and symptoms of menorrhagia may include soaking through one or more sanitary pads or tampons every hour for several consecutive hours, needing to use double sanitary protection to control menstrual flow, needing to change sanitary protection during the night, bleeding for a week or longer, passing large blood clots with menstrual flow, restricting daily activities due to heavy menstrual flow, and anemia.

The etiology of menorrhagia includes hormonal imbalance, uterine fibroid tumors, lack of ovulation, cervical or endometrial polyps, use of a nonhormonal IUD, pregnancy complications, medications (anti-inflammatory and anticoagulants), PID, thyroid disorders, endometriosis, and liver or kidney disease. Sometimes the etiology of menorrhagia is unknown. Diagnosis may include pelvic examination, Pap test, blood tests (anemia, thyroid, blood clotting), biopsy, and ultrasound.

Treatment varies according to the cause of the disease and may include iron supplements, taking over-the-counter pain relievers, oral contraceptives to inhibit ovulation, progestin therapy to decrease menstrual flow, and an IUD that releases progesterone. Surgical treatment options include D&C, endometrial ablation, and hysterectomy. Prevention of menorrhagia includes not using a nonhormonal IUD, abstinence, monogamy, use of latex condoms, and obtaining early diagnosis and treatment of STIs.

Metrorrhagia is bleeding between menstrual periods or extreme irregularity of the menstrual cycle. Metrorrhagia is common, but the true incidence is not known. Risk factors for metrorrhagia include hormonal imbalance, PID, oral contraceptives, ovarian cysts, uterine fibroid tumors, endometrial cancer, and endometriosis. Signs and symptoms may include bleeding between periods, irregular menstrual cycles, and cramping abdominal pain with bleeding.

The etiology of metrorrhagia includes hormonal imbalance, uterine fibroid tumors, cervical or endometrial polyps, pregnancy complications, infection, endometriosis, miscarriage, ectopic pregnancy, cancer, IUD, thyroid disorders, diabetes, and blood-clotting disorders. Diagnosis is based on record of menstrual cycle, physical examination, pelvic examination, blood tests (CBC, chemistry screen, and hormone levels), culture, Pap test, pregnancy test result, ultrasound, and biopsy. The treatment of metrorrhagia depends on the etiology and may include treating underlying conditions. Prevention of metrorrhagia includes early diagnosis and treatment of infections, and not using an IUD.

Premenstrual Syndrome and Premenstrual Dysphoric Disorder

Premenstrual syndrome (PMS) is a group of symptoms that start 1–2 weeks before menstruation and cease with the onset of menses. Estimates of the percentage of women affected by PMS vary widely in the United States. According to the American College of Obstetricians and Gynecologists, at least 85% of menstruating women have at least one PMS symptom as part of their monthly cycle. Risk factors for PMS include age, a family history of PMS, and previous anxiety, depression, or other mental health problems. PMS signs and symptoms may include breast swelling and tenderness, acne, bloating and weight gain, headache or joint pain, food cravings, irritability, mood swings, crying spells, fatigue, trouble sleeping, anxiety, and depression.

The etiology of PMS is idiopathic. Diagnosis is based on medical history, including signs and symptoms, when signs and symptoms occur, and how much the signs and symptoms interfere

with daily life. No single PMS treatment works for everyone. Over-the-counter pain relievers may help ease cramps, headaches, backaches, and breast tenderness. Oral contraceptives can also be used to reduce PMS signs and symptoms.

To manage premenstrual syndrome:

- Avoid salt, caffeine, and alcohol.
- Exercise regularly.
- Eat a healthy diet.
- Get enough sleep.
- Take calcium and vitamin B₆.
- Manage stress.
- Take pain relievers.
- Take oral contraceptives.

For some women, the symptoms of PMS are severe enough to interfere significantly with their lives. They have a type of PMS called premenstrual dysphoric disorder (PMDD). PMDD affects 3–8% of menstruating women. Risk factors for PMDD include a family history of PMS or PMDD; personal or family history of depression, postpartum depression, or a mood disorder; sexual or physical abuse; and chronic stress. Diagnostic criteria for PMDD are listed in Table 11-1 ►.

The etiology of PMDD is idiopathic. PMDD is diagnosed based on a complete medical history, physical examination, pelvic examination, and psychiatric evaluation. In addition to the PMS treatments listed above, antidepressants have also been shown to help some women with PMDD. Unfortunately, PMDD cannot be prevented.

Endometriosis

Endometriosis is a condition in which endometrial tissue from the uterus becomes embedded outside the uterus. During menstruation, the tissue may be pushed through the fallopian tubes or carried by blood or lymph. The endometrial tissue can embed on the ovaries, the outer surface of the uterus, the bowels, or other abdominal organs and appears rarely on other body structures and organs. Endometriosis affects 8.5 million women in North America and 176 million women worldwide. Risk factors for endometriosis include age, family history, never having given birth, and menstrual history (short, heavy, or long periods). The most common symptom of endometriosis

TABLE 11-1 PMDD Diagnostic Criteria from the American Psychiatric Association

- A. In most menstrual cycles during the past year, five (or more) of the following symptoms were present for most of the time during the last week of the luteal phase, began to remit within a few days after the onset of the menstrual flow, and were absent in the week postmenses, with at least one of the five symptoms being either the following numbered 1, 2, 3, or 4.
 1. Markedly depressed mood, feelings of hopelessness, or self-deprecating thoughts
 2. Marked anxiety, tension, feelings of being “keyed up” or “on edge”
 3. Marked affective lability (e.g., feeling suddenly sad or tearful or increased sensitivity to rejection)
 4. Persistent and marked anger or irritability or increased interpersonal conflicts
 5. Decreased interest in usual activities (e.g., work, school, friends, hobbies)
 6. Subjective sense of difficulty in concentrating
 7. Lethargy, easy fatigability, or marked lack of energy
 8. Marked change in appetite, overeating, or specific food cravings
 9. Hypersomnia or insomnia
 10. A subjective sense of being overwhelmed or out of control
 11. Other physical symptoms, such as breast tenderness or swelling, headaches, joint or muscle pain, a sensation of “bloating,” weight gain
- B. The disturbance markedly interferes with work or school or with usual social activities and relationships with others (e.g., avoidance of social activities, decreased productivity and efficiency at work or school).
- C. The disturbance is not merely an exacerbation of the symptoms of another disorder, such as major depression disorder, panic disorder, dysthymia disorder, or a personality disorder (although it may be superimposed on any of these disorders).
- D. Criteria A, B, and C must be confirmed by prospective daily ratings during at least two consecutive symptomatic cycles.

is pelvic pain. Other signs and symptoms may include diarrhea or constipation, abdominal bloating, menorrhagia, metrorrhagia, and fatigue. It is estimated that 30–40% of women with endometriosis are infertile.

The etiology of endometriosis is idiopathic. The only certain means of diagnosing endometriosis is by seeing it with laparoscopy. Treatment of endometriosis may include taking over-the-counter pain relievers, hormone therapy to decrease estrogen to slow or halt the proliferation of endometrial tissue, and surgery. Endometriosis cannot be prevented.

Disorders of Pregnancy

Ectopic Pregnancy

An ectopic pregnancy is a pregnancy in which the fertilized ovum implants in a tissue other than the uterus. The most common site of an ectopic pregnancy is the fallopian tubes. In rare cases, ectopic pregnancies occur in the ovary, cervix, and stomach area. Approximately 1–2% of pregnancies in the United States are ectopic. Risk factors for ectopic pregnancy include PID, previous ectopic pregnancy, endometriosis, previous tubal or pelvic surgery, infertility and infertility treatments, cigarette smoking, and structural abnormalities of the uterus or fallopian tubes.

Ectopic pregnancy can be difficult to diagnose because signs and symptoms may mirror early pregnancy. Classic signs and symptoms of ectopic pregnancy include one-sided lower abdominal pain, vaginal bleeding, and a positive pregnancy test. If the area of the abnormal pregnancy ruptures and bleeds, signs and symptoms may get worse and may include severe, sharp, and sudden pain in the lower abdominal area; feeling faint or actually fainting; referred pain to the shoulder area; and internal bleeding due to a rupture, which may lead to shock. Ectopic pregnancy is often caused by a condition that blocks or slows the movement of a fertilized egg through the fallopian tube to the uterus. Most cases are a result of scarring caused by a past infection in the fallopian tubes, surgery of the fallopian tubes, or a previous ectopic pregnancy. Up to 50% of women who have ectopic pregnancies have PID. Some ectopic pregnancies can be

due to birth defects of the fallopian tubes, endometriosis, complications of a ruptured appendix, or scarring caused by previous pelvic surgery.

Diagnosis of ectopic pregnancy is based on signs and symptoms, pelvic examination, ultrasound, and a positive pregnancy test. Ectopic pregnancies cannot continue to term, so the pregnancy must be terminated. In cases in which a rupture will occur, the woman may be given a drug that targets the rapidly dividing fetal cells and allows the body to reabsorb the pregnancy. In the event of a rupture, a laparotomy is done to stop blood loss and terminate the pregnancy. Most forms of ectopic pregnancy that occur outside the fallopian tubes are not preventable. Prevention of an ectopic pregnancy in the fallopian tube includes abstinence, monogamy, use of latex condoms, and early diagnosis and treatment of STIs.

Spontaneous Abortion or Miscarriage

A spontaneous abortion, commonly called a miscarriage, is loss of a fetus before the 20th week of pregnancy. It is estimated that up to 50% of all fertilized ova die and are spontaneously aborted, usually before the woman knows she is pregnant. Among known pregnancies, the rate of spontaneous abortion is approximately 15–20% and the occurrence is usually between the 7th and 12th weeks of pregnancy. Risk factors for spontaneous abortion include maternal age and previous miscarriage. Possible signs and symptoms of spontaneous abortion may include low back pain or abdominal pain that is dull, sharp, or cramping; vaginal bleeding; and tissue or clotlike material discharged from the vagina. About 20% of pregnant women have some vaginal bleeding during the first 3 months of pregnancy; approximately half of these women have a miscarriage.

Most miscarriages result from a genetic abnormality of the fetus. Other possible causes of spontaneous abortion include infection, physical problems in the mother, hormonal factors, immune responses, or serious systemic diseases of the mother such as diabetes or thyroid disease. Diagnosis of spontaneous abortion is based on pelvic examination, ultrasound, and pregnancy test. If all the pregnancy tissue does not exit the body, the woman may be given an

injection of a drug that stops embryonic cells from dividing and multiplying, or she may need surgery to eliminate the remaining tissue. Spontaneous abortion cannot be prevented except by avoiding known risk factors.

Preeclampsia

Preeclampsia is defined as high blood pressure and excess protein in the urine after 20 weeks of pregnancy in a woman who previously had normal blood pressure. Preeclampsia occurs in 6–10% of all pregnancies in the United States and is most often seen in first-time pregnancies, pregnant teens, and women over age 40. Risk factors include a history of high blood pressure before pregnancy, previous history of preeclampsia, obesity prior to pregnancy, carrying more than one baby, and a history of diabetes, kidney disease, lupus, scleroderma, and rheumatoid arthritis. Mild preeclampsia is characterized by high blood pressure and the presence of protein in the urine. Severe preeclampsia may also include headaches, blurred vision, and inability to tolerate bright light, upper abdominal pain, nausea, vomiting, dizziness, decreased urine output, and sudden weight gain.

The etiology of preeclampsia is idiopathic. Diagnosis of preeclampsia is based on increased blood pressure and urine protein levels. If close enough to term, the baby will be delivered. However, if a woman has mild preeclampsia and is not close enough to term to be delivered, rest, frequent monitoring of blood pressure and urine, reduced salt intake, and increased water intake may be recommended. Severe preeclampsia may be treated with blood pressure medication. Preeclampsia cannot be prevented, but if risk factors are present, women can prepare for it by seeking a doctor's attention early in pregnancy.

Gestational Diabetes Mellitus

Gestational diabetes is diabetes mellitus associated with pregnancy. Reported rates of gestational diabetes range from 2 to 10% of pregnancies. Increased metabolic demands during pregnancy require higher insulin levels, but certain normal maternal physiological changes during pregnancy can result in insufficient insulin levels, which, if uncorrected, result in diabetes. These

changes include increased levels of estrogen and progesterone, which interfere with insulin action. In addition, the placenta normally inactivates insulin. The normal pregnancy-induced elevation of stress hormones—such as cortisol, epinephrine, and glucagon—raises blood glucose. Insulin requirements continue to rise as pregnancy approaches term. In a normal pregnancy, more insulin is secreted to compensate for these changes, but in some women insulin levels remain low as blood glucose continues to rise.

The etiology of gestational diabetes is idiopathic. Risk factors include a family history of type 2 diabetes, age, previous diagnosis of gestational diabetes or prediabetes, and being obese. Women at risk for developing gestational diabetes should be screened early and monitored throughout their pregnancy.

Most women with gestational diabetes are asymptomatic. Rarely, gestational diabetes may cause excessive thirst or increased urination. Diagnosis is made via a glucose tolerance test, which measures the body's ability to use glucose. Treatment consists of regular blood glucose monitoring, dietary control of blood glucose levels, weight control, exercise, and possibly insulin therapy. Untreated gestational diabetes puts the fetus at risk of premature delivery and respiratory distress syndrome, excessive birth weight, hypoglycemia, jaundice, and an increased risk for type 2 diabetes. Prevention of gestational diabetes includes eating a healthy diet, maintaining a healthy weight, not gaining too much weight during pregnancy, and engaging in exercise on a regular basis.

Female Age-Related Diseases

In older females, pubic hair thins and grays and the external reproductive genitalia acquire a wrinkled and sagging appearance due to a decrease in elasticity. Physical changes in the aging female include shrinking of internal reproductive organs, decrease in vaginal secretions and elasticity, and a decrease in breast tissue volume. The pH of vaginal secretions becomes more alkaline, making older women more susceptible to vaginal infections. Increased stimulation and lubrication may be necessary to facilitate sexual intercourse.

Menopause, the cessation of menstrual periods, is not a disease but is a physical change related to aging. Menopause usually takes place between 45 and 55 years of age. As a woman ages, the ovaries produce less estrogen and progesterone, causing cessation of ovulation and menstruation. Removal of the ovaries also causes menopause. Common physical signs and symptoms of menopause include hot flashes, night sweats, trouble sleeping, mood swings, trouble focusing, hair loss or thinning, facial hair growth, and vaginal dryness. Menopause is diagnosed by signs and symptoms, elevated FSH, and low estrogen. Hormone therapy may help with menopause signs and symptoms; however, each woman and her physician must weigh the benefits and risks of hormone therapy.

Uterine prolapse is falling or sliding of the uterus from its normal position in the pelvic cavity into the vaginal canal. The prevalence of uterine prolapse is not known. Risk factors include age, one or more vaginal births, and giving birth to a large baby. Signs and symptoms may include feelings of heaviness in the pelvic area, urinary difficulties, and a feeling like you are sitting on a small ball. Uterine prolapse is caused by trauma to the fascia, muscle, and pelvic ligaments during pregnancy and delivery or atrophy of the pelvic floor muscles with age. The ligaments and muscles become so overstretched that they can no longer hold the uterus in place, so the uterus falls or sags downward. Diagnosis of uterine prolapse may include pelvic examination, ultrasound, and MRI. Treatment consists of strengthening the pelvic floor muscles (Kegel exercises), inserting a pessary (removable device placed in the vagina designed to support areas of pelvic organ prolapse) into the vagina to support the uterus, or surgery. Uterine prolapse is not preventable.

Cystocele is a downward displacement of the urinary bladder into the vagina. The prevalence of cystocele is not known. Risk factors for cystocele include age, one or more vaginal births, and having a hysterectomy. Signs and symptoms may include pelvic pressure, urinary urgency and frequency, and incontinence. The etiology of cystocele includes trauma to the fascia, muscle, and pelvic ligaments during pregnancy and delivery, or atrophy of the pelvic floor muscles

with age. Diagnosis is made by pelvic examination. Treatment includes Kegel exercises, vaginal pessary, or surgery. Cystocele is not preventable.

Rectocele is bulging of the front wall of the rectum into the vagina. The prevalence of rectocele is not known. Risk factors for rectocele include aging, one or more vaginal births, and obesity. Signs and symptoms may include discomfort, constipation, and fecal incontinence. The etiology of rectocele is trauma to the fascia, muscle, and pelvic ligaments during pregnancy and delivery, or atrophy of the pelvic floor muscles with age. Diagnosis may include pelvic examination, MRI, and x-rays. Treatment includes Kegel exercises, vaginal pessary, and surgery. Rectocele is not preventable.

Anatomy and Physiology of the Male Reproductive System

The male reproductive system produces, transfers, and introduces sperm into the female reproductive tract. The external genitalia includes the penis and scrotum. The penis deposits sperm into the female reproductive tract. The body of the penis is called the shaft. The slightly bulging head is called the glans penis. The loose skin covering the penis continues over the glans penis to form the prepuce or foreskin. The foreskin is removed during circumcision. Glands in the foreskin secrete a waxy substance called smegma that collects between the glans penis and the foreskin. Three cylinders of erectile tissue fill the shaft of the penis. During sexual arousal, these tissues fill with blood, causing the penis to enlarge and become erect. The scrotum is a saclike structure that hangs behind the penis.

The testes reside inside the scrotum and produce sperm. The testes reside outside the body because sperm production requires a temperature lower than the rest of the body. Sperm production begins in the male at puberty and continues through life. The tightly coiled **seminiferous tubules** are the sperm-producing factories within the testes. Sperm produced in the seminiferous tubules then travel via the male reproductive duct system (epididymis, ductus deferens, and urethra) to exit the body. The male reproductive system is illustrated in Figure 11-6 ►.

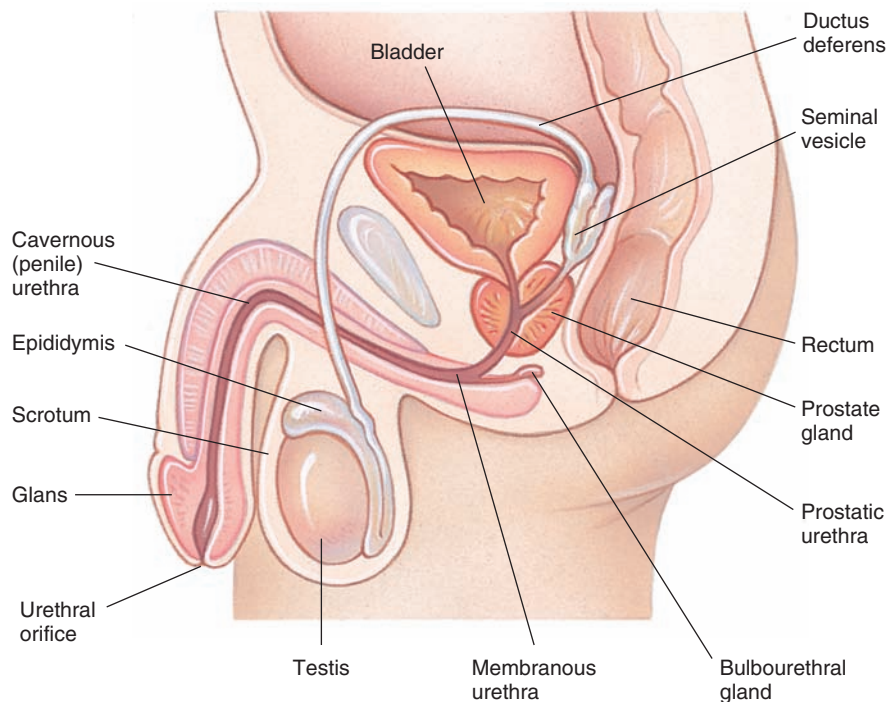


Figure 11-6 ► The male reproductive system.

Semen is a viscous, white secretion with a slightly alkaline pH that contains sperm and accessory gland secretions. A typical ejaculate contains about 1 teaspoon of semen and contains between 40 and 100 million sperm. Once ejaculated, sperm live for 24–72 hours in the female reproductive tract.

The accessory glands including the **seminal vesicles**, the **prostate gland**, and the **bulbourethral glands** produce most of semen. The seminal vesicles are paired sacs located at the base of the bladder and produce roughly 65% of the fluid portion of semen. The seminal vesicles secrete a thick, yellowish fluid that nourishes and activates the sperm. The bulbourethral glands are tiny glands located below the prostate gland and produce roughly 5% of the fluid portion of semen. The bulbourethral glands secrete a clear fluid into the urethra during sexual arousal that serves as a lubricant for sexual intercourse and neutralizes the acidity of residual urine in the urethra. The prostate gland sits just below the bladder and encircles the urethra and produces roughly 30% of the fluid portion of semen.

The prostate secretes a thin, milky fluid that enhances sperm motility and neutralizes the acidity of the male urethra and of the woman's vagina.

Testosterone secretion begins approximately 2 months after conception. During the last 2 months of gestation testosterone normally causes the testes to descend into the scrotum. Testosterone is barely detectable in boys by the age of 4–6 months. The onset of puberty at about age 13 is marked by the secretion of GnRH by the hypothalamus, which triggers secretion of FSH and LH by the anterior pituitary gland. FSH and LH stimulate enlargement of the testes, the first sign of puberty in males. LH prompts the testes to secrete testosterone and FSH stimulates sperm production. The increased production of testosterone promotes the development of secondary sex characteristics including pubic, axillary, and facial hair; darker and thicker skin; increased activity of oil and sweat glands; deepening of the voice; enlargement of skeletal muscles; and an increase in bone growth and density.

Diagnostic Tests and Procedures

Physical examination of the male reproductive system includes visual examination of the external genitalia. The testes are palpated to determine the presence of tumors. A digital rectal examination (DRE) allows the physician to palpate the prostate gland (Figure 11-7 ►). Prostate-specific antigen (PSA), which is produced by cells of the

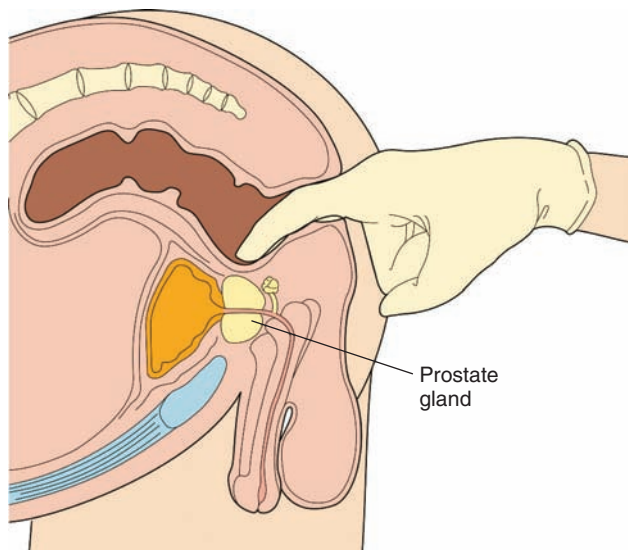


Figure 11-7 ► Digital rectal examination to detect abnormalities of the prostate gland.

prostate gland, can be measured to determine the risk for prostate cancer and benign prostatic hyperplasia. **Urodynamic testing** assesses how well the bladder and urethra are storing and releasing urine. **Cystoscopy** (Figure 11-8 ►) is used to view the urethra and bladder. If abnormalities or tumors are discovered, a biopsy may be performed. Imaging tests including x-rays, MRI, CT scan, and PET scan may be used to aid in staging cancers. Other laboratory tests that may be performed include urinalysis and hormone testing.

Diseases of the Male Reproductive System

Prostatitis

Prostatitis is inflammation or infection of the prostate gland. The National Institutes of Health (NIH) estimates 10–12% of men experience prostatitis-like symptoms. Prostatitis affects mostly young and middle-aged men. Prostatitis has been classified by the NIH into four categories: category 1 is acute bacterial prostatitis, category 2 is chronic bacterial prostatitis, category 3 is chronic prostatitis (chronic pelvic pain syndrome), and category 4 is asymptomatic inflammatory prostatitis. Risk factors for prostatitis

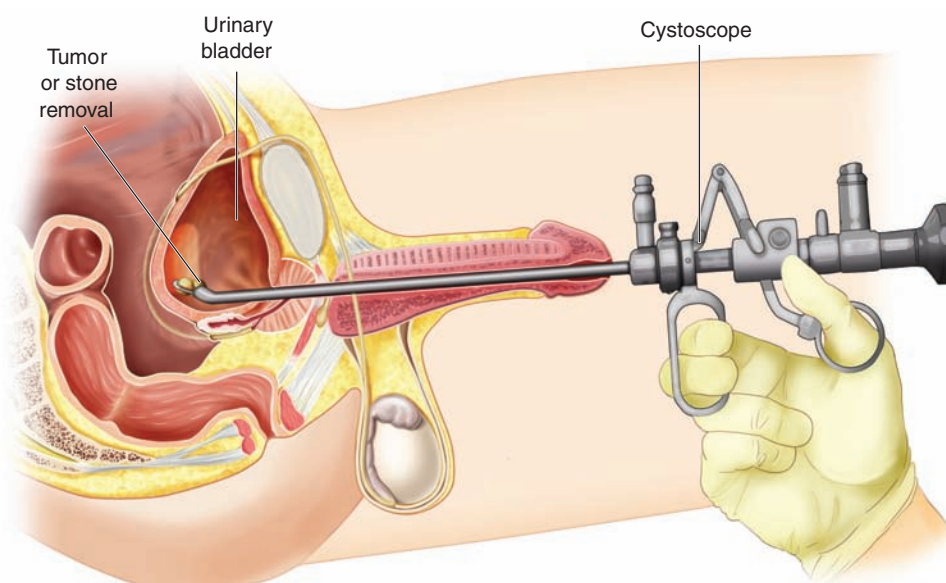


Figure 11-8 ► Cystoscopy. A cystoscope is used to view the bladder.

include a past episode of prostatitis, an infection in the bladder or urethra, pelvic trauma, dehydration, using a urinary catheter, unprotected sexual intercourse, and having HIV/AIDS. The signs and symptoms vary depending on the category of prostatitis.

- **Acute bacterial prostatitis:** sudden onset of fever and chills; flulike symptoms; pain in the prostate gland, lower back, or groin; urinary problems, including increased urinary urgency and frequency, difficulty or pain when urinating, inability to completely empty the bladder, and blood-tinged urine; and painful ejaculation
- **Chronic bacterial prostatitis:** slow onset of signs and symptoms resembling acute bacterial prostatitis that wax and wane
- **Chronic prostatitis:** resembles chronic bacterial prostatitis, without fever
- **Asymptomatic inflammatory prostatitis:** usually found during examination for another condition and may not require treatment

Diagnosis requires medical history, physical examination, DRE, culture, cystoscopy, and urodynamic testing. Over-the-counter pain relievers and several weeks of treatment with antibiotics are required for bacterial prostatitis. Smooth muscle relaxants may aid urination for chronic prostatitis. Prevention includes practicing good hygiene, maintaining adequate hydration, and early diagnosis and treatment for infections.

Epididymitis

Epididymitis is inflammation of the epididymis. The NIH estimates there are 600,000 cases of epididymitis in men between the ages of 18 and 35 in the United States. Risk factors include having multiple sex partners, personal history of an STI, past prostate or urinary tract infections, an uncircumcised penis, anatomical abnormality of the urinary tract, prostate enlargement, and medical procedures that affect the urinary tract (surgery, catheter, and cystoscopy). Signs and symptoms may include a tender, swollen, red, or warm scrotum; testicle pain and tenderness (usually on one side); painful urination or an urgent or frequent need to urinate; painful intercourse or ejaculation; chills or fever; a lump on

the testicle; enlarged lymph nodes in the groin; pain or discomfort in the lower abdomen or pelvic area; discharge from the penis; and blood in the semen. The etiology of epididymitis may include STIs, other infections, the heart medication amiodarone, tuberculosis, and urine in the epididymis. Diagnosis may include physical examination, DRE, STI testing, ultrasound, and PET scan of the testicles. Treatment may include antibiotics. Over-the-counter pain relievers, bed rest, and elevation and application of ice packs to the scrotum relieve symptoms and swelling. Prevention of epididymitis includes abstinence, monogamy, use of latex condoms, and early diagnosis and treatment for infections.

Orchitis

Orchitis is inflammation of the testes. The prevalence of orchitis is not known. Orchitis occurs in 20–35% of men with mumps, and in 10% of these cases, the condition exists in both testicles. Risk factors for orchitis include not being immunized against mumps, recurring urinary tract infections, surgery that involves the genitals or urinary tract, being born with an abnormality in the urinary tract, multiple sexual partners, sex with a partner who has an STI, unprotected sex, and a personal history of STIs. Signs and symptoms may include testicular swelling on one or both sides, pain ranging from mild to severe, tenderness in one or both testicles, nausea, vomiting, fever, and penile discharge. Orchitis can be caused by a viral or bacterial infection. Diagnosis may include physical examination, STI testing, urinalysis, ultrasound, and PET scan of the testicles. Treatment for viral orchitis is symptomatic and may include taking over-the-counter pain relievers, bed rest, and elevation and application of cold packs to the scrotum. Bacterial orchitis is treated with antibiotics. Prevention of orchitis includes vaccination against mumps, abstinence, monogamy, use of latex condoms, and early diagnosis and treatment for STIs.

Cryptorchidism

Cryptorchidism is not a disease but a failure of the testes to descend from the abdominal cavity, where they develop during fetal life, to the scrotum. Approximately 3% of full-term male

newborns have an undescended testicle at birth, and up to 30% of premature male newborns have at least one undescended testicle. Since the testicles typically descend late in fetal development, during the 8th month of gestation, the infant born before this time has a greater chance of having cryptorchidism. In over 50% of people being seen for cryptorchidism, the testes descend by the third month, and by age 1, 80% of all undescended testes have descended into the scrotum. Risk factors for cryptorchidism include low birth weight and premature birth. The major sign of cryptorchidism is not being able to feel one or both of the testicles in the scrotum. The etiology of cryptorchidism is usually abnormal testicular development. The affected testicles frequently have a short spermatic artery, poor blood supply, or both. Diagnosis of cryptorchidism may involve palpating the scrotum and abdomen to locate the testicles, ultrasound, MRI, laparoscopy, and hormone and genetic testing.

Testicular Cancer

Testicular cancer is cancer in one or both testicles. Testicular cancer is the most common cancer in men 20–35 years old. The ACS estimates that in 2013 approximately 7,920 cases of testicular cancer will be diagnosed and 370 men will die from testicular cancer in the United States. Testicular cancer affects younger men with an average age of diagnosis of 33. Risk factors for testicular cancer include cryptorchidism, abnormal testes development, and a family or personal history of testicular cancer. Signs and symptoms may include a lump on a testicle that is painless, testicular enlargement or swelling, and a sensation of heaviness or aching in the lower abdomen or scrotum. The etiology of testicular cancer is idiopathic. Diagnosis may include a medical history, physical examination, ultrasound, serum tumor marker tests (alpha-fetoprotein, lactate dehydrogenase, beta-human chorionic gonadotropin), radical inguinal orchiectomy (surgery to remove a testicle), and biopsy. Imaging tests may aid in staging the cancer. Treatment may include surgery, radiation therapy, chemotherapy, and stem cell transplant. The 5-year relative survival rate is 95%; if the

cancer has not metastasized outside the testicle, the 5-year relative survival rate is 99%. Testicular cancer cannot be prevented.

Male Age-Related Diseases

In older males, pubic hair thins and grays and the external reproductive genitalia acquire a wrinkled and sagging appearance due to a decrease in elasticity. Testosterone levels decline gradually and the testes decrease in size. Sperm count is slightly reduced and prostate gland secretions are decreased. Increased stimulation may be necessary to achieve erection.

A common problem in older males is enlargement of the prostate gland, or **benign prostatic hyperplasia (BPH)**. BPH is so common that it is estimated that it affects 60% of men in their 60s and 80–90% of men in their 70s and 80s. Risk factors for BPH include age and a family history of enlarged prostate. Less than half of all men with BPH are symptomatic; signs and symptoms may include dribbling at the end of urinating, inability to urinate, incomplete emptying of the bladder, incontinence, needing to urinate two or more times per night, pain with urination, bloody urine, slowed or delayed start of the urinary stream, straining to urinate, strong and sudden urge to urinate, and weak urine stream. The cause of BPH is idiopathic and it is probably a normal part of the aging process in men. Dihydrotestosterone (DHT) is a metabolite of testosterone. BPH is directly dependent on DHT. Diagnosis of BPH may include medical history, DRE, urine analysis, culture, PSA blood test, ultrasound, urodynamic testing, and cystoscopy. Treatment options include watchful waiting, medications such as an alpha blocker to relax smooth muscle in the prostate and increase urinary flow, hormone therapy to block the conversion of testosterone to DHT, and surgery.

Prostate Cancer

Prostate cancer is a malignant tumor that forms in the tissue of the prostate gland. The ACS estimates that in 2013 approximately 238,590 cases of prostate cancer will be diagnosed and 29,720 men will die from prostate cancer in the United States. An estimated 1.1 million men were diagnosed with prostate cancer and 307,000 died of

prostate cancer worldwide in 2012. It usually affects older men so the average age of diagnosis is 67. Prostate cancer is the second leading cause of cancer death in men, behind only lung cancer.

Risk factors for prostate cancer include age (most men with prostate cancer are over age 65), a family history of prostate cancer, race (prostate cancer is more common among African American men than among men of other races), certain prostatic changes (prostatic intraepithelial neoplasia), and certain genome changes. Men with prostate cancer may be asymptomatic; signs and symptoms may include not being able to pass urine; having a hard time starting or stopping the urine flow; needing to urinate often, especially at night; weak flow of urine; urine flow that starts and stops; pain or burning during urination; difficulty having an erection; blood in the urine or semen; and frequent pain in the lower back, hips, or upper thighs.

The etiology of prostate cancer is idiopathic. Testosterone stimulates growth of prostate tumor cells. Diagnosis is based on DRE, PSA blood test, ultrasound, and biopsy. Because prostate cancer often grows very slowly, some men (especially those who are older or who have other major health problems) may never need treatment for their cancer. An approach called active surveillance may be suggested. This approach involves closely watching the cancer (DRE, PSA testing, ultrasounds, and possible biopsy). Imaging tests may be used to aid in staging the cancer. Treatment of prostate cancer may include surgery, radiation therapy, and chemotherapy. Orchiectomy or removal of the testes will decrease testosterone production. Other medications may be used to decrease testosterone production by the testes, block uptake of testosterone by tumor cells, or stop production of testosterone by the adrenal glands. The 5-year relative survival rate is 100% for local and regional prostate cancer and 31% for distant prostate cancer. Prostate cancer is not preventable, but early diagnosis is helpful.

Prostate screening is controversial. A 2010 analysis concluded that routine screening with either a DRE or PSA is not supported by the evidence as there is no mortality benefit from screening. The USPSTF recommended against PSA screening in healthy men in October 2011, finding that the potential risks outweigh the

potential benefits. The ACS does not support routine screening for prostate cancer. The ACS recommends that doctors discuss the pros and cons of testing and that men should be offered the possibility of a DRE and a PSA test if they are over age 50 with a life expectancy of more than 10 years (or over age 40 if they are in a high-risk group).

Erectile Dysfunction

Erectile dysfunction (ED), also known as impotence, is the inability of the male to achieve and maintain an erection sufficient for sexual intercourse. ED is said to be primary if the man has never been able to complete intercourse successfully and secondary if intercourse has been achieved successfully at least once. More than 18 million men in the United States age 20 and over suffer from ED. As men age, their risk for ED increases dramatically: 70% of men age 70 or over report erectile problems, compared with 5% of men age 20–40.

ED may be caused by psychological or physical factors. The dilation of penile arteries that leads to engorgement of the erectile tissue of the penis and then erection is under the control of the autonomic nervous system, which is affected by stress, anxiety, and fear. ED may be caused by diabetes, kidney disease, neurological disease, vascular disease, and prostate cancer treatment.

Diagnosis of ED may include medical history, physical exam, blood tests (CBC, liver and kidney function test, lipid panel, thyroid function test, blood hormone studies), urinalysis, ultrasound, overnight erection test, and psychological exam. Treatment may include medication to increase blood flow to erectile tissue by relaxing smooth muscle of the penis. Other treatments include surgery, penis pump or implant, therapy, and treatment for underlying conditions. There is no specific treatment to prevent ED, but making healthy lifestyle choices and managing existing health problems may help.

Sexually Transmitted Infections

Sexually transmitted infections (STIs) are infections spread by sexual contact. Sexual contact includes unprotected oral, anal, or vaginal

intercourse. STIs are caused by bacteria, viruses, and protozoans. WHO estimates 448 million new cases of curable STIs (syphilis, gonorrhoea, chlamydia, and trichomoniasis) occur annually throughout the world in adults ages 15–49. The CDC estimates 20 million new STIs occur each year in the United States, almost half of them among people ages 15–24. Table 11–2 ► shows the top 10 states for bacterial STIs in the United States. STIs cost the United States health care system an estimated \$16 billion annually. Some STIs cause no or relatively minor signs and symptoms, but undetected infections can have serious consequences, including infertility, PID, cervical cancer, and adverse pregnancy outcomes. Risk factors for STIs include unprotected sex, multiple sex partners, a history of STIs, being under the age of 25, and sexual contact while under the influence of drugs or alcohol. Prevention of STIs includes abstinence, monogamy, and condom use. STIs are diagnosed by staining, culture, DNA test, and antigen or antibody testing.

HIV/AIDS

Human immunodeficiency virus/acquired immunodeficiency syndrome HIV/AIDS is discussed fully elsewhere in this text.

Healthy Aging

HIV/AIDS

The number of older people living with HIV/AIDS has increased over the years, partly because of the effectiveness of antiretroviral therapy that permits people with HIV/AIDS to live longer.

Recently 15% of all new HIV/AIDS cases have occurred among people age 50 or older. Overall, about 1 in 4 people living with HIV/AIDS are age 59 and older.

As the U.S. population grows older, and as more people live healthier and more active, long lives, the risk for HIV/AIDS will grow among older people. Elders should take precautions and practice safe sex to prevent HIV/AIDS and other STIs.

Prevention PLUS!

Preventing STIs

- **Don't have sex.** The best way to prevent any STI is to practice abstinence, or not having vaginal, oral, or anal sex.
- **Be monogamous.** Have a sexual relationship with one partner who has been tested negative for STIs.
- **Use condoms.** Protect yourself with a condom EVERY time you have vaginal, anal, or oral sex. Condoms should be used for any type of sex with every partner. For vaginal sex, use a latex male condom or a female polyurethane condom. For anal sex, use a latex male condom. For oral sex, use a dental dam. A dental dam is a rubbery material that can be placed over the anus or the vagina before sexual contact.
- **Know that birth control pills, shots, implants, spermicides, or diaphragms will not protect you from STIs.** If you use one of these methods, be sure to also use a latex condom or dental dam correctly every time you have sex.
- **Talk with your sex partner(s) about STIs and using condoms.** It's up to you to make sure you are protected. Remember, it's *your* body!

- **Don't abuse drugs or alcohol.** Heavy drinking and drug use can put you at greater risk of STIs. Drinking too much and using drugs are linked to sexual risk-taking, such as having sex with more than one partner and not using condoms.
- **Get tested for STIs.** If either you or your partner has had other sexual partners in the past, get tested for STIs before becoming sexually active. Don't wait for your doctor to ask you about getting tested—ask your doctor!
- **Have regular pelvic examinations.** Ask your health care provider to test you for STIs.

Think Critically

1. What is the best way to prevent STIs?
2. When should you and a new sex partner get tested for STIs?

Source: www.womenshealth.gov

TABLE 11–2 Top Ten States Ranked by Rate (per 100,000) of Reported Bacterial STI Cases in 2011

Rank	Primary and secondary syphilis	Chlamydia	Gonorrhea
1	Louisiana	Alaska	Louisiana
2	Maryland	Mississippi	Mississippi
3	Georgia	Louisiana	Alabama
4	Illinois	South Carolina	North Carolina
5	Florida	Alabama	South Carolina
6	California	North Carolina	Georgia
7	Mississippi	Georgia	Arkansas
8	Arkansas	New Mexico	Ohio
9	New York	Arkansas	Alaska
10	Nevada	New York	Illinois

Source: www.cdc.gov/std/stats11/default.htm

Gonorrhea

The CDC estimates that more than 700,000 people are infected with gonorrhea each year in the United States. Less than half of these infections are reported to the CDC (334,826 in 2012). WHO estimates 62 million people are infected with gonorrhea annually worldwide. Gonorrhea is transmitted through sexual contact and during childbirth. Men infected with gonorrhea may be asymptomatic. If they occur, signs and symptoms include a burning sensation when urinating; a white, yellow, or green discharge from the penis; or painful or swollen testicles. Most women infected with gonorrhea are asymptomatic. When they occur, signs and symptoms include a painful or burning sensation when urinating, increased vaginal discharge, or vaginal bleeding between periods. The etiology of gonorrhea is the gram-negative coccus bacterium *Neisseria gonorrhoeae* (see Figure 11–9 ► and Figure 11–10 ►).

Untreated gonorrhea can cause serious and permanent health problems in both women and men. In women, gonorrhea is a common cause of PID. In men, gonorrhea can cause epididymitis, which can lead to infertility if left untreated. Gonorrheal infection in a newborn can cause

blindness, joint infection, or a life-threatening blood infection. To prevent this infection, a drop of erythromycin is routinely placed in the eyes of newborn babies. Treatment of gonorrhea as soon as it is detected in pregnant women will reduce the risk of these complications.

Gonorrhea can be diagnosed by DNA testing (nucleic acid amplification, nucleic acid

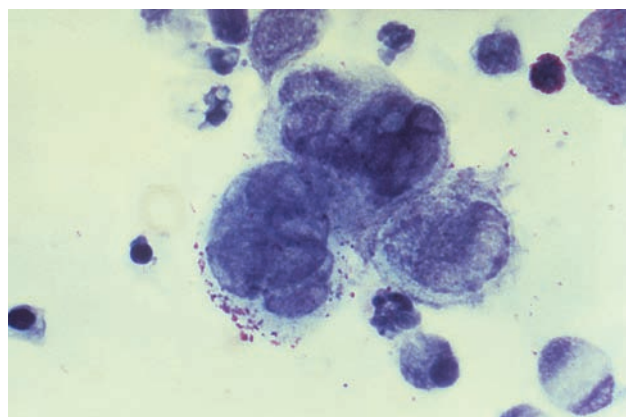


Figure 11–9 ► Gram-stained cervical smear. Note the gram-negative diplococci *Neisseria gonorrhoeae* bacteria. (Centers for Disease Control and Prevention/Joe Miller)



Figure 11-10 ► Collection of a specimen from a male with suspected *Neisseria gonorrhoeae* infection. (Centers for Disease Control and Prevention/Renelle Woodall)

hybridization), culture, enzyme-linked immunosorbent assay, or Gram stain. Gonorrhea is treated with an injection of an antibiotic plus an oral antibiotic. Drug-resistant strains of gonorrhea are increasing in many areas of the world, including the United States, and successful treatment of gonorrhea is becoming more difficult.

Syphilis

In 2012, 15,667 cases of primary and secondary syphilis were reported to the CDC. In the United States, men having sex with men accounts for 75% of syphilis cases. The WHO estimates that more than 12 million people are infected with syphilis annually worldwide. Many people infected with syphilis do not have signs or symptoms for years and risk complications if they are not treated. **Syphilis** is transmitted through sexual contact, through direct contact with a syphilis **chancre**, and during childbirth.

The primary stage of syphilis begins with the appearance of one or more chancres where *Treponema pallidum* entered the body (Figure 11-11 ►). Chancres are small, painless, firm, round lesions that usually last 3–6 weeks and heal without treatment. If no treatment is administered, the infection progresses to the secondary stage.

The secondary stage is characterized by a nonitchy, widespread rash. The rash may appear as rough, red, or reddish-brown spots (Figure 11-12 ►). Other signs and symptoms of secondary syphilis may include fever, fatigue, headache, sore throat, patchy hair loss, weight loss, muscle aches, fatigue, and swollen lymph nodes. The signs and symptoms of secondary syphilis will resolve with or without treatment.

If no treatment is administered the infection progresses to the latent stage, during which there are no signs and symptoms. This stage can last for years. In approximately 15% of

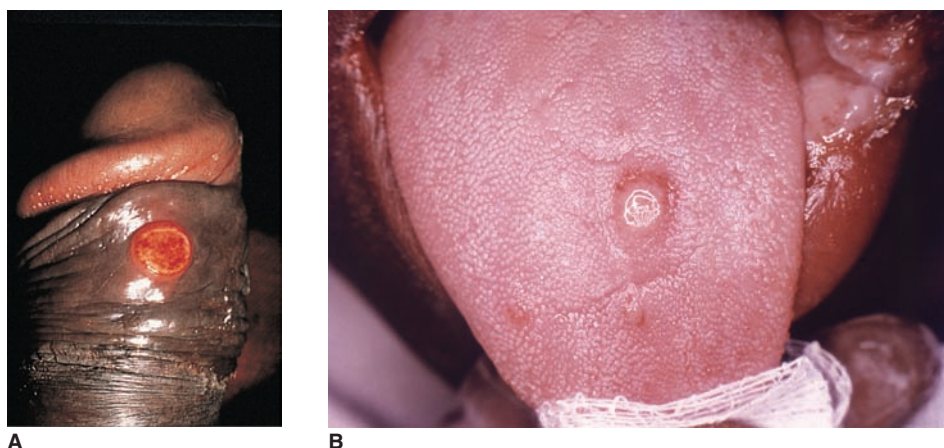


Figure 11-11 ► Chancre of primary syphilis (A) on the penis and (B) on the tongue. (Photo B: Centers for Disease Control and Prevention/Robert E. Sumpter)



Figure 11-12 ▶ Secondary syphilis rash. (Centers for Disease Control and Prevention/Robert Sumpter)

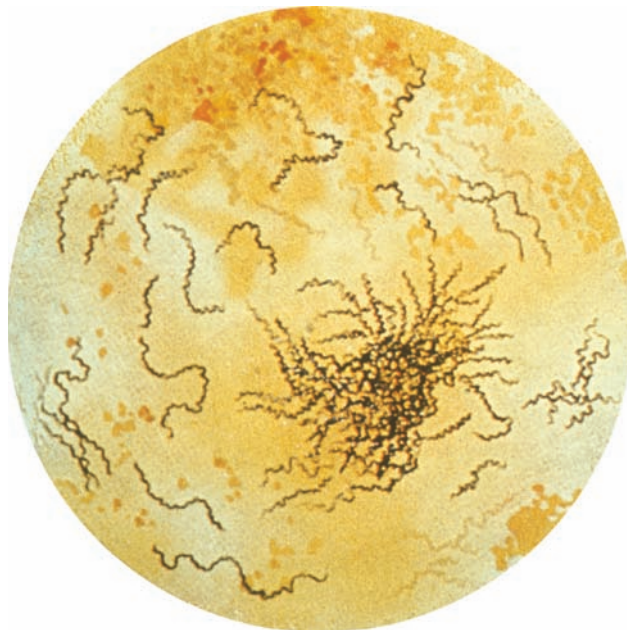


Figure 11-13 ▶ *Treponema pallidum*.

patients in the latent stage of syphilis who have not been treated, the disease continues to progress and they develop late syphilis. Late syphilis can appear 10–15 years after the infection was first acquired. In the late stage of syphilis internal organs, including the brain, nerves, eyes, heart, blood vessels, liver, bones, and joints, are damaged. Signs and symptoms of the late stage of syphilis include difficulty coordinating muscle movements, paralysis, numbness, gradual blindness, and dementia. This damage may be serious enough to cause death.

Syphilis can be transmitted to the fetus via the placenta (congenital syphilis). Approximately 50% of these pregnancies result in stillbirth or neonatal death. Congenital syphilis kills more than 1 million babies each year worldwide. Most babies with congenital syphilis are asymptomatic. Signs and symptoms in a newborn may include a rash, fever, irritability, failure to thrive, and saddle nose (bridge of the nose collapses). The U.S. Preventative Services Task Force recommends screening pregnant women for syphilis at 12–16 weeks gestation.

The etiology of syphilis is the gram-negative spirochete bacterium *Treponema pallidum* (Figure 11-13 ▶). Diagnosis of syphilis may

include darkfield microscopic visualization of the bacterium from chancre scrapings and antibody testing (venereal disease research laboratory test, rapid plasma regain test, enzyme immunoassay test, fluorescent treponemal antibody absorption test, and *Treponema pallidum* particle agglutination assay). Syphilis is treated with antibiotics; however, development of antibiotic-resistant strains is a serious threat. Treatment will kill the syphilis bacterium and prevent further damage, but it will not repair damage already done.

Chlamydia

In 2012, 1,422,976 cases of chlamydia were reported to the CDC, but most people with chlamydia are not aware of their infections. WHO estimates that more than 92 million chlamydial infections occur annually worldwide. Chlamydia is transmitted by sexual contact and during vaginal childbirth. Chlamydia is known as a “silent” disease because the majority of infected people are asymptomatic. In women, signs and symptoms may include an abnormal vaginal discharge, a burning sensation when urinating, lower abdominal pain, low back pain, nausea, fever, pain during intercourse,

and bleeding between menstrual periods. In men, signs or symptoms may include a penile discharge, a burning sensation when urinating, and burning and itching around the urethral orifice.

In women, untreated infection can spread into the uterus or fallopian tubes and cause PID. This happens in up to 10–15% of women with untreated chlamydia. The CDC recommends yearly chlamydia testing of all sexually active women age 25 or younger, older women with risk factors for chlamydial infections (those who have a new sex partner or multiple sex partners), and all pregnant women. Complications among men are rare. Infection sometimes spreads to the epididymis, causing pain, fever, and, infrequently, sterility. Rarely, genital chlamydial infection can cause arthritis that can be accompanied by skin lesions and inflammation of the eye and urethra known as Reiter's syndrome. In pregnant women, there is some evidence that untreated chlamydial infections can lead to premature delivery. Babies who are born to infected mothers can get chlamydial infections in their eyes and respiratory tracts. Chlamydia is a leading cause of early infant pneumonia and conjunctivitis in newborns. The etiology of chlamydia is the gram-negative coccus bacterium *Chlamydia trachomatis*.

Diagnosing chlamydia requires culture, DNA testing (nucleic acid amplification test, nucleic acid hybridization test), and antigen testing (direct fluorescent antibody test). Antibiotics are used to treat chlamydia.

Trichomoniasis

There are an estimated 7.4 million trichomoniasis cases annually in the United States, with over 180 million cases reported annually worldwide. Only about 30% of those infected develop signs and symptoms of trichomoniasis. Signs and symptoms in men may include itching or irritation inside the penis, burning after urination or ejaculation, or penile discharge. Signs and symptoms in women may include itching, burning, redness or soreness of the genitals, discomfort with urination, or a thin discharge with an unusual smell that can be clear, white, yellowish, or greenish. The etiology

of trichomoniasis is the protozoan *Trichomonas vaginalis*. Diagnosis of trichomoniasis may include potassium hydroxide whiff test (KOH is added to vaginal discharge; a strong fishy odor is a positive result), wet-mount microscopic visualization, Pap test, culture, DNA testing (nucleic acid hybridization, nucleic acid amplification), and trichomonas antigen test. Both partners should be treated with antiparasitic medications.

Genital Herpes

Genital herpes is an STI caused by the herpes simplex virus (HSV). HSV-2 most often causes genital herpes. HSV-2 can be spread through secretions from the mouth or genitals. HSV-1 usually affects the mouth and lips and causes cold sores or fever blisters. However, HSV-1 can spread from the mouth to the genitals during oral sex. The CDC estimates in the United States 16.2%, or about one out of six, people age 14–49 have a HSV-2 infection. WHO estimates worldwide 536 million people age 15–49 have a HSV-2 infection. Genital HSV-2 infection is more common in women (approximately one out of five women age 14–49) than in men (approximately one out of nine men age 14–49). This may be due to male-to-female transmission being more likely than female-to-male transmission.

Most people with a HSV-2 infection are asymptomatic; signs of a HSV-2 include one or more painful blisters on or around the genitals (Figure 11–14 ►). The blisters rupture, leaving ulcers that may take up to 4 weeks to heal. The herpes virus goes latent and can become active from time to time, causing an outbreak of blisters. Over time these recurrences usually decrease in frequency. Babies born to infected mothers can be exposed to the virus during the birthing process. This may result in brain damage, blindness, or death for the newborn. If a woman has active genital herpes at delivery, a cesarean delivery is usually performed.

HSV-2 may be diagnosed by medical history, physical examination, culture, nucleic acid amplification, and antibody testing. There is no treatment that can cure herpes, but antiviral medications can shorten outbreaks and make them less severe. Taking antiviral medications



Figure 11-14 ► Genital herpes blisters as they appear on the (A) penis, (B) vaginal entrance, and (C) anus.

daily may stop outbreaks from occurring and may decrease transmission of the virus.

Genital Warts

Genital warts are benign neoplastic growths on the epidermis of the genitals. According to the CDC, approximately 6.2 million new cases of sexually transmitted human papillomavirus (HPV) infections occur annually in the United States. At least 20 million people in the United States

are already infected with HPV. At least 50% of sexually active men and women acquire genital HPV infection at some point in their lives. By age 50, at least 80% of women will have acquired genital HPV infection. The WHO estimates the prevalence of genital HPV infection in the world to be 440 million.

Genital warts are single or multiple growths or bumps that appear in the genital area and sometimes are cauliflower shaped (Figure 11-15 ►). Genital warts can appear on the vulva, in or



Figure 11-15 ► Genital warts. (Photo A: Courtesy of Centers for Disease Control and Prevention/Dr. Wiesner, 1972, Photo B: Centers for Disease Control and Prevention/Susan Lindsley)

Promote Your Health

STI Testing

Knowing your STI status is a critical step to stopping STI transmission. If you know you are infected you can take steps to protect yourself and your partners.

Be sure to ask your health care provider to test you for STIs—asking is the only way to know whether you are

receiving the right tests. And don't forget to tell your partner to ask a health care provider about STI testing as well.

around the vagina or anus, on the cervix, and on the penis, scrotum, groin, or thigh. Approximately 90% of genital warts are caused by HPV 6 and HPV 11.

Most people who become infected with HPV are asymptomatic, and the immune system will clear the infection in 90% of cases within 2 years. Genital warts may appear within weeks after sexual contact with an infected partner, or they might not develop for several months. Genital warts are diagnosed by physical examination and can be removed by medications that erode the wart tissue. The warts can be removed with electrocautery, cryosurgery, and laser surgery.

There is no cure for HPV or genital warts. The American Academy of Pediatrics recommends that all girls and boys between the ages of 11 and 12 receive the three-dose vaccine for HPV. Gardasil® offers protection against HPV 16, HPV 18, HPV 6, and HPV 11.

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Diseases at a Glance

Reproductive System

Disease or Disorder	Etiology	Signs and Symptoms
Pelvic inflammatory disease	Infection	Lower abdominal pain, fever, unusual vaginal discharge that may have a foul odor, painful intercourse, painful urination, and irregular menstrual bleeding
Cervical cancer	Human papillomavirus	Abnormal vaginal bleeding, an unusual vaginal discharge, pelvic pain, pain during intercourse
Endometrial cancer	Idiopathic	Vaginal bleeding after menopause, abnormal bleeding, abnormal vaginal discharge, pelvic pain, pain during intercourse
Fibroid tumors of the uterus		Asymptomatic; excessive vaginal bleeding, pelvic pressure, abdominal pain, abdominal enlargement, pain during intercourse
Ovarian cancer	Idiopathic	Bloating, pelvic or abdominal pain, trouble eating or feeling full quickly, changes in urinary urgency or frequency
Breast cancer	Idiopathic	Lump or mass with irregular borders in the breast; swelling of all or part of the breast; skin irritation and dimpling; breast or nipple pain; nipple retraction; redness, scaliness, or thickening of the nipple or breast skin; a nipple discharge other than breast milk
Fibroadenomas	Idiopathic	Firm, round, smooth, rubbery, easily movable, clearly defined edges
Breast cysts	Idiopathic	Smooth, easily movable round or oval breast lump with defined edges with a soft grape or water-filled balloon or firm texture, breast pain or tenderness in the area of the cyst, cyst may vary in size during the menstrual cycle
Fibrocystic breast changes	Idiopathic	Breast swelling or thickening, lumps within the breast that may vary in size and texture, breast pain or tenderness

Diagnosis	Treatment	Prevention
Physical examination, pelvic examination, STI testing, ultrasound	Antibiotics	Abstinence, monogamy, using latex condoms, early diagnosis and treatment of STIs
Pelvic examination, Pap test, HPV DNA test, colposcopy, cervical biopsy	Surgery, radiation therapy, chemotherapy	Abstinence, HPV vaccine
Medical history, pelvic examination, hysteroscopy, removal of endometrial tissue, CBC, CA 125 blood test	Surgery, radiation therapy, chemotherapy, hormone therapy	Not preventable
Pelvic examination, ultrasound	Watchful waiting, oral contraceptives, uterine artery embolization, focused ultrasound surgery, endometrial ablation, birth control pills, hysterectomy	Not preventable
CT or MRI scan, ultrasound, laparoscopy, biopsy, CA 125 blood test	Surgery, radiation therapy, chemotherapy	Not preventable
Breast examination, mammogram, ultrasound, biopsy	Surgery, radiation therapy, chemotherapy, targeted therapy, hormone therapy	Not preventable
Breast examination, mammogram, ultrasound, MRI, fine needle biopsy	None, removal via surgery, laser ablation, cryoablation	Not preventable
Breast examination, mammogram, ultrasound, fine needle aspiration, biopsy	None, oral contraceptives, discontinue hormone replacement therapy, surgery	Not preventable
Breast examination, mammogram, ultrasound, fine needle aspiration, biopsy	None, supportive bra, OTC pain relievers, oral contraceptives	Not preventable

Disease or Disorder	Etiology	Signs and Symptoms
Amenorrhea	<p>Primary—chromosomal abnormalities, problems with the hypothalamus, pituitary disease, lack of reproductive organs, or structural abnormality of the vagina</p> <p>Secondary—pregnancy, contraceptives, breastfeeding, stress, medication, chronic illness, hormone imbalance, low body weight, excessive exercise, thyroid disorders, pituitary tumor, uterine scarring, premature menopause</p>	No menstrual period
Dysmenorrhea	<p>Primary—prostaglandins</p> <p>Secondary—PID, use of an IUD, uterine fibroid tumors, endometriosis</p>	Cramping, dull to severe pelvic, lower back pain that may radiate to other areas
Menorrhagia	Hormonal imbalance, uterine fibroid tumors, lack of ovulation, cervical or endometrial polyps, use of a nonhormonal IUD, pregnancy complications, medications, PID, thyroid disorders, endometriosis, liver or kidney disease, unknown	Excessive or prolonged bleeding during menstruation. Soaking through one or more sanitary pads or tampons every hour for several consecutive hours, needing to use double sanitary protection to control menstrual flow, needing to change sanitary protection during the night, bleeding for a week or longer, passing large blood clots with menstrual flow, restricting daily activities due to heavy menstrual flow, signs and symptoms of anemia
Metrorrhagia	Hormonal imbalance, uterine fibroid tumors, cervical or endometrial polyps, pregnancy complications, infection, endometriosis, miscarriage, ectopic pregnancy, cancer, use of an IUD, thyroid disorders, diabetes, and blood-clotting disorders	Bleeding between periods, irregular menstrual cycles, cramping and abdominal pain with bleeding
Premenstrual syndrome	Idiopathic	Breast swelling and tenderness, acne, bloating and weight gain, headache or joint pain, food cravings, irritability, mood swings, crying spells, fatigue, trouble sleeping, anxiety, depression
Premenstrual dysphoric disorder	Idiopathic	See Table 11–1
Endometriosis	Idiopathic	Pelvic pain, diarrhea or constipation, abdominal bloating, menorrhagia, metrorrhagia, fatigue

Diagnosis	Treatment	Prevention
Pregnancy test, pelvic examination, blood test to check hormone levels, progesterin challenge test	If needed—lifestyle changes related to weight, physical activity, or stress level; amenorrhea caused by thyroid or pituitary disorders may be treated with medications	Maintaining a sensible exercise program, maintaining a normal weight, eating a healthy diet, avoiding excessive alcohol consumption, not smoking, finding healthy outlets for stress
Pelvic examination, ultrasound, laparoscopy, hysteroscopy	Antibiotics, oral contraceptives, OTC pain relievers, treatment of uterine fibroid tumors or endometriosis	Abstinence, monogamy, use of latex condoms, early diagnosis and treatment of STIs
Pelvic examination, Pap test, blood tests (anemia, thyroid, blood clotting), biopsy, ultrasound	Iron supplements, OTC pain relievers, oral contraceptives, IUD that releases progesterin therapy, D&C, endometrial ablation, hysterectomy	Not using a nonhormonal IUD, abstinence, monogamy, use of latex condoms, early diagnosis and treatment of STIs
Record of menstrual cycle, physical examination, pelvic examination, blood tests (CBC, chemistry screen, hormone levels), culture, Pap test, pregnancy test, ultrasound, biopsy	Treatment of underlying conditions	Early diagnosis and treatment of infections, not using an IUD
Medical history including signs and symptoms and when signs and symptoms occur, how much the signs and symptoms interfere with daily life	OTC pain relievers; oral contraceptives; avoiding salt, caffeine, and alcohol; exercising; eating a healthy diet; getting enough sleep; taking calcium and vitamin B ₆ ; stress management	Not preventable
Complete medical history, physical examination, pelvic examination, psychiatric evaluation	PMS treatments plus antidepressants	Not preventable
Laparoscopy	OTC pain relievers	Not preventable

Disease or Disorder	Etiology	Signs and Symptoms
Ectopic pregnancy	PID, surgery of the fallopian tubes, previous ectopic pregnancy, birth defects of the fallopian tubes, endometriosis, complications of a ruptured appendix, scarring from a previous pelvic surgery	One-sided lower abdominal pain, vaginal bleeding, positive pregnancy test; severe, sharp, and sudden pain in the lower abdominal area, feeling faint or fainting, referred pain to the shoulder area, shock
Spontaneous abortion or miscarriage	Genetic abnormality of the fetus, infection, physical problems in the mother, hormonal factors, immune responses, diabetes, thyroid disease	Low back pain or abdominal pain that is dull, sharp, or cramping; vaginal bleeding; tissue or clotlike material discharged from the vagina
Preeclampsia	Idiopathic	Mild preeclampsia—high blood pressure, presence of protein in the urine Severe preeclampsia—also includes headaches, blurred vision, inability to tolerate bright light, upper abdominal pain, nausea, vomiting, dizziness, decreased urine output, sudden weight gain
Gestational diabetes mellitus	Pregnancy	None, excessive thirst or increased urination
Prostatitis	Idiopathic; infection	Acute bacterial prostatitis—fever and chills; flu-like symptoms; pain in the prostate gland, lower back, or groin; urinary problems, including increased urinary urgency and frequency, difficulty or pain when urinating, inability to completely empty the bladder, and blood-tinged urine; painful ejaculation Chronic bacterial prostatitis—frequent and urgent need to urinate, pain or burning sensation when urinating, pelvic pain, excessive urination during the night, pain in the lower back and genital area, difficulty starting urination or diminished urine flow, occasional blood in semen or urine, painful ejaculation, slight fever, recurring bladder infections Chronic prostatitis—similar to chronic bacterial without fever
Epididymitis	STIs, other infections, the heart medication amiodarone (Pacerone®), tuberculosis, urine in the epididymis	Tender, swollen, red, or warm scrotum; testicle pain and tenderness (usually on one side); painful urination or an urgent or frequent need to urinate; painful intercourse or ejaculation; chills and fever; a lump on the testicle; enlarged lymph nodes in the groin; pain or discomfort in the lower abdomen or pelvic area; discharge from the penis; and blood in the semen

Diagnosis	Treatment	Prevention
Signs and symptoms, pelvic examination, ultrasound, pregnancy test	Surgery, medication	In the fallopian tubes—abstinence, monogamy, use of latex condoms, early diagnosis and treatment of STIs Outside the fallopian tube—not preventable
Pelvic examination, ultrasound, positive pregnancy test	Medication	Not preventable
Blood pressure, urine protein levels	Delivery of the baby, rest, frequent monitoring of blood pressure and urine, limiting salt, drinking water, blood pressure medication	Not preventable
Glucose tolerance test	Regular blood glucose monitoring, dietary control of blood glucose levels, weight control, exercise, insulin injections	Eating a healthy diet, maintaining a healthy weight, not gaining too much weight during pregnancy, regular exercise
Medical history, physical examination, DRE, culture, cystoscopy, urodynamic testing	Categories 1 and 2—OTC pain relievers, Category 3—Medication to relax smooth muscle, OTC pain relievers Category 4—may not require treatment	Practice good hygiene, adequate hydration, early diagnosis and treatment for infections
Physical examination, DRE, STI testing, ultrasound, PET scan of the testicles	Antibiotics, OTC pain relievers, bed rest, elevation of the scrotum, and application of ice packs to the scrotum	Abstinence, monogamy, use of latex condoms, and early diagnosis and treatment for infections.

Disease or Disorder	Etiology	Signs and Symptoms
Orchitis	Viral or bacterial infection	Testicular swelling on one or both sides, pain ranging from mild to severe, tenderness in one or both testicles, nausea and vomiting, fever, and penile discharge
Cryptorchidism	Abnormal testicular development	Inability to feel one or both testicles in the scrotum
Testicular cancer	Idiopathic	Lump on a testicle that is painless, testicular enlargement or swelling, a sensation of heaviness or aching in the lower abdomen or scrotum
Gonorrhea	<i>Neisseria gonorrhoeae</i>	Men—asymptomatic; burning sensation when urinating; white, yellow, or green discharge from the penis; painful or swollen testicles Women—asymptomatic; painful or burning sensation when urinating, increased vaginal discharge, vaginal bleeding between periods
Syphilis	<i>Treponema pallidum</i>	Primary—chancre Secondary—rash, fever, fatigue, headache, sore throat, patchy hair loss, weight loss, muscle aches, fatigue, swollen lymph nodes Latent—no signs or symptoms Late—difficulty coordinating muscle movements, paralysis, numbness, gradual blindness, dementia Congenital—asymptomatic; rash, deafness, teeth deformities, saddle nose
Chlamydia	<i>Chlamydia trachomatis</i>	Majority asymptomatic Women—abnormal vaginal discharge, burning sensation when urinating, lower abdominal pain, low back pain, nausea, fever, pain during intercourse, bleeding between menstrual periods Men—penile discharge, burning sensation when urinating, burning and itching around the urethral orifice
Trichomoniasis	<i>Trichomonas vaginalis</i>	Asymptomatic Men—itching or burning inside the penis, burning after urination or ejaculation, penile discharge Women—itching, burning, redness, or soreness of the genitals; discomfort with urination; thin discharge with an unusual odor

Diagnosis	Treatment	Prevention
Physical examination, STI testing, urinalysis, ultrasound, PET scan of the testicles	Viral orchitis—OTC pain relievers, bed rest, elevation, application of cold packs to the scrotum Bacterial orchitis—antibiotics	Vaccinating against mumps, abstinence, monogamy, use of latex condoms, and early diagnosis and treatment for STIs
Palpating the scrotum and abdomen, ultrasound, MRI, laparoscopy, hormone and genetic testing	Hormone therapy, surgery	Not preventable
Medical history, physical examination, ultrasound, serum tumor marker tests, radical inguinal orchiectomy, biopsy	Surgery, radiation therapy, chemotherapy, high-dose chemotherapy, stem cell transplant	Not preventable
DNA testing, culture, enzyme-linked immunosorbent assay, gram stain	Antibiotics	Abstinence, monogamy, condom use
Darkfield microscopic visualization, antibody testing	Antibiotics	Abstinence, monogamy, condom use
Culture, DNA testing, antigen testing	Antibiotics	Abstinence, monogamy, condom use
KOH whiff test, wet-mount microscopic visualization, Pap test, culture, DNA testing, antigen test	Antiparasitic medication	Abstinence, monogamy, condom use

Disease or Disorder	Etiology	Signs and Symptoms
Genital herpes	Herpes simplex virus type I and II	Asymptomatic; painful blisters on or around the genitals
Genital warts	Human papillomavirus	Asymptomatic; growths or bumps in the genital area and are sometimes cauliflower shaped
Menopause	Aging	Hot flashes, night sweats, trouble sleeping, mood swings, trouble focusing, hair loss or thinning, facial hair growth, vaginal dryness
Uterine prolapse	Pregnancy, childbirth, aging	Feeling of heaviness in the pelvic area, urinary difficulties, and a feeling like you are sitting on a small ball
Cystocele	Pregnancy, childbirth, aging	Pelvic pressure, urinary urgency and frequency, incontinence
Rectocele	Pregnancy, childbirth, aging	Discomfort, constipation, fecal incontinence
Benign prostate hyperplasia	Idiopathic	Dribbling at the end of urinating, inability to urinate, incomplete emptying of the bladder, incontinence, needing to urinate two or more times per night, pain with urination, bloody urine, slowed or delayed start of the urinary stream, straining to urinate, strong and sudden urge to urinate, and weak urine stream
Prostate cancer	Idiopathic	Asymptomatic; not being able to pass urine; having a hard time starting or stopping the urine flow; needing to urinate often, especially at night; weak flow of urine; urine flow that starts and stops; pain or burning during urination; difficulty having an erection; blood in the urine or semen; frequent pain in the lower back, hips, or upper thighs
Erectile dysfunction	Age, psychological, diabetes, kidney disease, neurological disease, vascular disease, prostate cancer treatment	Inability to achieve and maintain an erection sufficient for sexual intercourse

Diagnosis	Treatment	Prevention
Physical examination and history, culture, nucleic acid amplification, antibody testing	Antiviral medication	Abstinence, monogamy, condom use
Warts—physical examination HPV—abnormal Pap tests, HPV DNA test	Medication, electrocautery, cryosurgery, laser surgery	Abstinence, monogamy, condom use
Signs and symptoms, elevated FSH, low estrogen	Hormone therapy	Not preventable
Pelvic examination, imaging tests (ultrasound, MRI)	Kegel exercises, vaginal pessary, surgery	Not preventable
Pelvic examination	Kegel exercises, vaginal pessary, surgery	Not preventable
Pelvic examination, imaging tests (MRI, x-rays)	Kegel exercises, vaginal pessary, surgery	Not preventable
Medical history, DRE, urine analysis, culture, PSA blood test, ultrasound, urodynamic testing, cystoscopy	Watchful waiting, medication to relax smooth muscle, hormone therapy, surgery	Not preventable
DRE, PSA blood test, ultrasound, biopsy	Active surveillance, surgery, radiation therapy, hormone therapy	Not preventable
Medical history, physical examination, blood tests, urinalysis, ultrasound, overnight erection test, psychological examination	Medication to relax smooth muscle, surgery, penis pump or implant, therapy	Not preventable

Interactive Exercises

Cases for Critical Thinking

1. A young woman reports severe pelvic pain. Laproscopic examination found endometrial tissue on the uterine wall and ovaries. Name this disease. What is the etiology? What treatments are available?
2. A 16-year-old, sexually active woman complains of a green, frothy, foul-smelling vaginal discharge. What is the possible diagnosis? What tests would you perform? What treatment is available?
3. A 63-year-old male says he gets up several times a night to urinate but has difficulty getting urination started. A DRE reveals an enlarged prostate gland. What are the possible diagnoses? What tests would you perform? What treatment is available?
4. A woman has been infected with HSV-2. Describe how she can reduce the risk of transmission of the infection to her sexual partner.
5. Why do many physicians sometimes recommend active surveillance for prostate cancer?
6. When baby Christopher was born, the pediatrician discovered that his left testicle had not descended into the scrotum. Name this disease. What complications may arise? What treatments are available?

Multiple Choice

1. Which is the most common tumor among females?
 - a. ovarian cysts
 - b. breast cancer
 - c. uterine fibroids
 - d. cervical cancer
2. Syphilis is caused by _____.
 - a. human papillomavirus
 - b. herpes virus
 - c. *Trichomonas vaginalis*
 - d. *Treponema pallidum*
3. Which statement is false about syphilis?
 - a. Primary syphilis chancres heal after a few weeks.
 - b. Congenital syphilis can cause death of the fetus.
 - c. Syphilis is only transmitted by sexual contact.
 - d. Secondary syphilis is characterized by a non-itching rash.
4. Which disease can lead to pelvic inflammatory disease?
 - a. chlamydia
 - b. cystitis
 - c. prostatitis
 - d. herpes
5. Excessive or prolonged bleeding during menstruation is known as _____.
 - a. dysmenorrhea
 - b. amenorrhea
 - c. metrorrhagia
 - d. menorrhagia
6. Protrusion of the rectum into the posterior aspect of the vagina is known as _____.
 - a. uterine prolapse
 - b. cystocele
 - c. rectocele
 - d. sepsis
7. Painful or difficult menses is _____.
 - a. amenorrhea
 - b. dysmenorrhea
 - c. menorrhagia
 - d. metrorrhagia
8. Failure of the testes to descend from the abdominal cavity is _____.
 - a. orchitis
 - b. prostatitis
 - c. cryptorchidism
 - d. epididymitis

9. Fingerlike projections at the outer ends of the fallopian tubes are known as _____.
 a. hymen
 b. fimbriae
 c. ovarian follicles
 d. greater vestibular glands
10. A surge in which hormone causes ovulation?
 a. progesterone
 b. estrogen
 c. gonadotropin hormone
 d. luteinizing hormone

True or False

- _____ 1. Pelvic inflammatory disease can lead to infertility.
- _____ 2. The Pap test detects endometriosis.
- _____ 3. The most important risk factor for cervical cancer is infection by the human papillomavirus.
- _____ 4. HSV-2 causes syphilis.
- _____ 5. All men with benign prostatic hyperplasia are symptomatic.
- _____ 6. Benign breast conditions are common.
- _____ 7. Preeclampsia is a disease that occurs during pregnancy.
- _____ 8. The only certain means of diagnosing endometriosis is laparoscopy.
- _____ 9. The most common site for ectopic pregnancy is the ovary.
- _____ 10. The etiology of PMS is idiopathic.

Fill-Ins

1. The site of sperm development within the testes are the _____.
2. _____ is inflammation of the testes.
3. The most frequently reported bacterial STI in the United States is _____.
4. The _____ encircles the urethra.
5. _____ is inflammation of the prostate gland.
6. _____ is an STI caused by a protozoan.
7. HSV _____ usually causes cold sores; HSV _____ usually causes genital herpes.
8. _____ is downward displacement of the urinary bladder into the vagina.
9. _____ is the cessation of menstrual periods.
10. _____ is the inability to achieve and maintain an erection sufficient for sexual intercourse.

Chapter 12

Diseases and Disorders of the Endocrine System

Learning Objectives

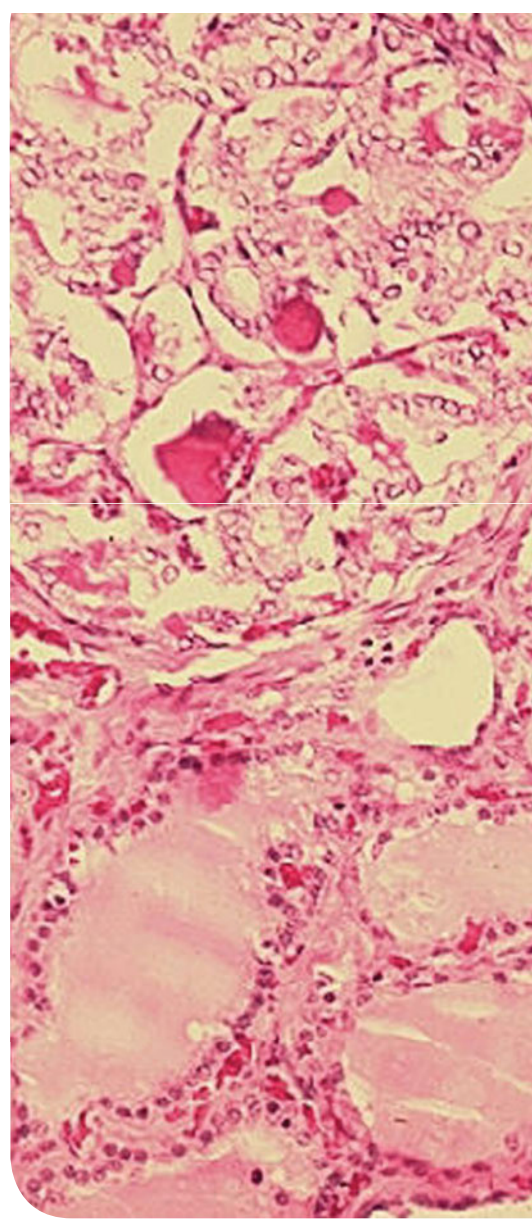
After studying this chapter, you should be able to

- Describe the functions of the endocrine glands and the hypothalamus
- Identify the various hormones and their functions
- Describe the consequences of hyposecretion and hypersecretion of endocrine hormones
- Describe the incidence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for diseases and disorders of the endocrine system
- Identify age-related changes in endocrine function

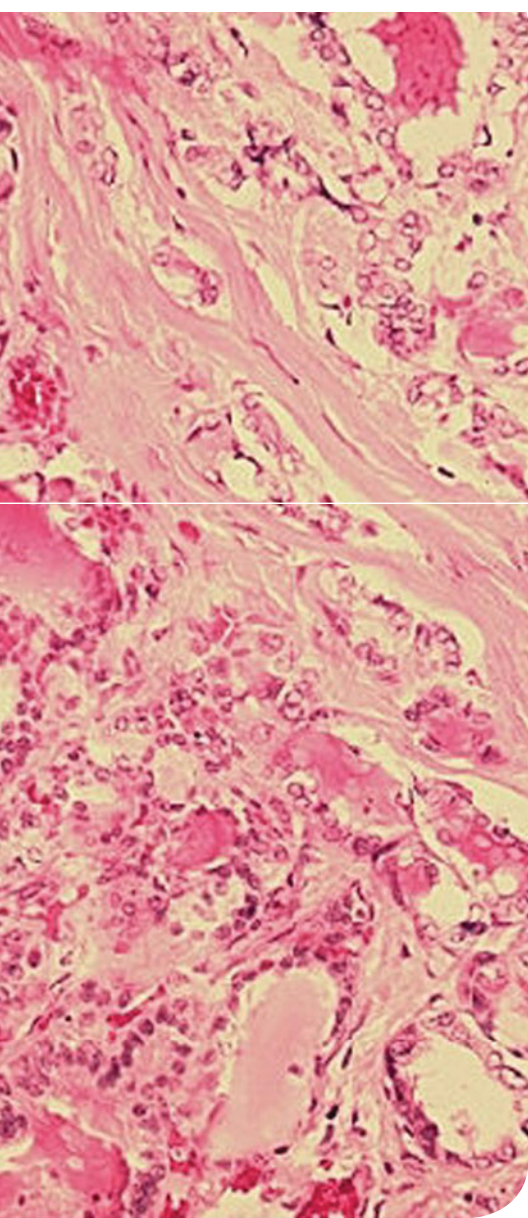
Fact or Fiction?

Urine production in diabetes insipidus patients can reach 20 liters (about 5 gallons) per day.

Fact: Diabetes insipidus is characterized by excessive urine production. In severe cases, fluid loss can reach 20 liters per day. Fatal dehydration will occur unless treatment is provided.



Pituitary carcinoma. (Centers for Disease Control and Prevention/Edwin P. Ewing, Jr.)



Disease Chronicle

Diabetes

Ancient Hindu writings record distinctive signs of diabetes thousands of years ago: large volumes of urine, to which ants and flies were attracted; intense thirst; and a wasting of the body. No treatment or cure existed for this mysterious ailment, which killed children and whose complications crippled survivors. It was not until the late 19th century, when diabetes was observed in dogs whose pancreas had been removed experimentally, that the disease could be linked to a specific organ. The key component of the pancreas was eventually isolated and identified as the protein hormone insulin. Today, instead of treating patients with insulin extracted from dog pancreas, human insulin is synthesized using recombinant DNA technology. Early diagnosis, treatment, and effective management have lengthened and greatly improved the lives of diabetics. However, no cure for diabetes exists.

Anatomy and Physiology Review

The endocrine system comprises a number of glands and glandular tissues that secrete chemical messengers called hormones into the blood. The endocrine glands include the pituitary gland, thyroid gland, parathyroid glands, adrenal glands, endocrine pancreas, and gonads (ovaries and testes) (Figure 12-1 ►). In addition, endocrine tissues are found in the heart, stomach, intestines, kidneys, and thymus. Endocrine hormones affect many aspects of body functions, including growth, development, energy metabolism, muscle and fat distribution, sexual development,

fluid and electrolyte balance, inflammation, and immune responses. See Table 12-1 ► for a list of endocrine glands, the hormones they produce, and the function of those hormones.

Hormones are secreted from endocrine glands into the bloodstream, and they affect the functions of cells at distant sites. Some hormones affect the whole body, while others act only on target or distant organs. Hormones are composed of either proteins (e.g., insulin) or chains of amino acids (e.g., epinephrine); others are steroids or fatty substances derived from cholesterol (e.g., estrogen). Most glandular activity is controlled by the pituitary, which is sometimes

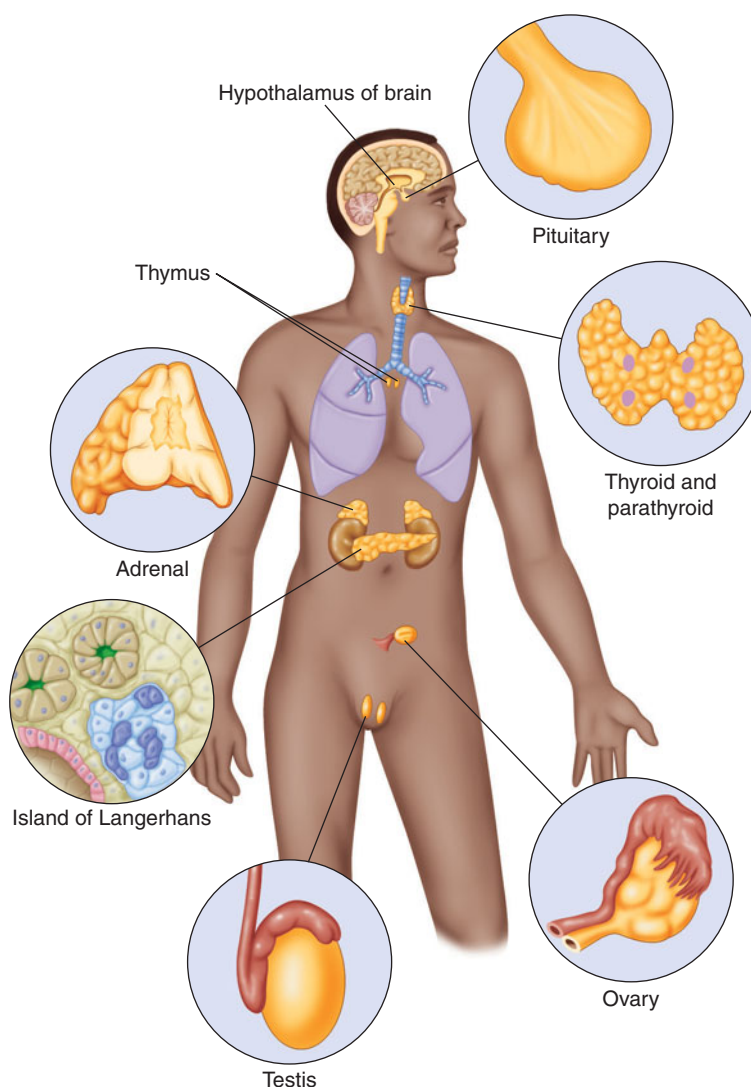


Figure 12-1 ► The endocrine glands.

TABLE 12–1 Endocrine Gland Hormones and Their Functions

Endocrine gland	Hormone	Hormone function
Anterior pituitary	Follicle-stimulating hormone (FSH)	Stimulates egg and sperm production
	Luteinizing hormone (LH)	Stimulates the production of sex hormones; LH surge causes ovulation
	Prolactin	Stimulates breast development and milk production
	Growth hormone (GH)	Increases the synthesis of protein and promotes the growth of bone and tissues
	Adrenocorticotrophic hormone (ACTH)	Stimulates the release of adrenal cortex hormones
	Thyroid-stimulating hormone (TSH)	Stimulates the production of the thyroid hormones
Posterior pituitary	Vasopressin or antidiuretic hormone (ADH)	Stimulates water absorption by the kidneys
	Oxytocin	Stimulates uterine contractions, milk release, and ejection of prostate gland secretions
Thyroid	Thyroid hormone (T_4 and T_3)	Increases metabolism and body heat production, regulates tissue growth and development
	Calcitonin	Decreases the concentration of calcium in blood
Parathyroid	Parathyroid hormone	Increases the calcium concentration in blood
Adrenal cortex	Mineralocorticoids	Regulate salt balance
	Glucocorticoids	Regulate carbohydrate, lipid, and protein metabolism
	Sex hormones (estrogen and testosterone)	Develop secondary sex characteristics
Adrenal medulla	Epinephrine	Causes vasodilation and increases heart rate, blood pressure, and respiration
	Norepinephrine	General vasoconstriction
Pancreas-alpha cells	Glucagon	Raises the level of blood glucose
Pancreas-beta cells	Insulin	Lowers the level of blood glucose
Pancreas-delta cells	Somatostatin	Inhibits the secretion of glucagon and insulin
Ovaries	Estrogen and progesterone	Regulate sexual development, secondary sex characteristics, and the reproductive cycle in females
Testes	Testosterone	Regulates sexual development and secondary sex characteristics in males

called the master gland. The pituitary itself is controlled by the hypothalamus, which is the homeostatic center of the body and is part of the central nervous system.

The body secretes hormones only as needed. For example, insulin is secreted when the blood sugar level rises. Another hormone, glucagon, works antagonistically to insulin and is released when the blood sugar level falls below normal. Hormones are potent chemicals, so their circulating levels must be carefully controlled. When the level of a hormone is adequate, its further release is stopped. This type of control is called a **negative-feedback mechanism**. Its importance becomes clearer as specific diseases of the endocrine system are considered.

Pituitary Gland

The pituitary gland is a pea-sized organ located at the base of the brain. Also called the hypophysis, the pituitary is composed of an anterior lobe called the **adenohypophysis** and a posterior lobe called the **neurohypophysis**. A stalk called the **infundibulum** connects the pituitary gland to the floor of the hypothalamus. The pituitary gland is regulated by the hypothalamus and, with feedback control, by circulating hormones (Figure 12-2 ►).

The anterior pituitary produces six major hormones: **prolactin**, **growth hormone (GH)**, **adrenocorticotropic hormone (ACTH)**, **luteinizing hormone (LH)**, **follicle-stimulating hormone (FSH)**, and **thyroid-stimulating hormone (TSH)**. These six hormones are collectively called **tropic hormones** (pronounced TROH-pik), meaning that they control the function of other endocrine glands (Figure 12-3 ►). The hormones of the posterior pituitary, **antidiuretic hormone (ADH)** and **oxytocin**, are produced in the hypothalamus and stored in the posterior pituitary.

Hormones of the Anterior Pituitary

Growth Hormone GH, also known as somatotropin, affects all parts of the body by promoting growth of tissues and bone. Before puberty, GH stimulates the growth of long bones, increasing the child's height. Soft tissues—organs such as the liver, heart, and kidneys—also increase in size and develop under the influence of growth hormone. After adolescence, growth hormone is secreted in lesser amounts but continues to promote tissue replacement and repair.

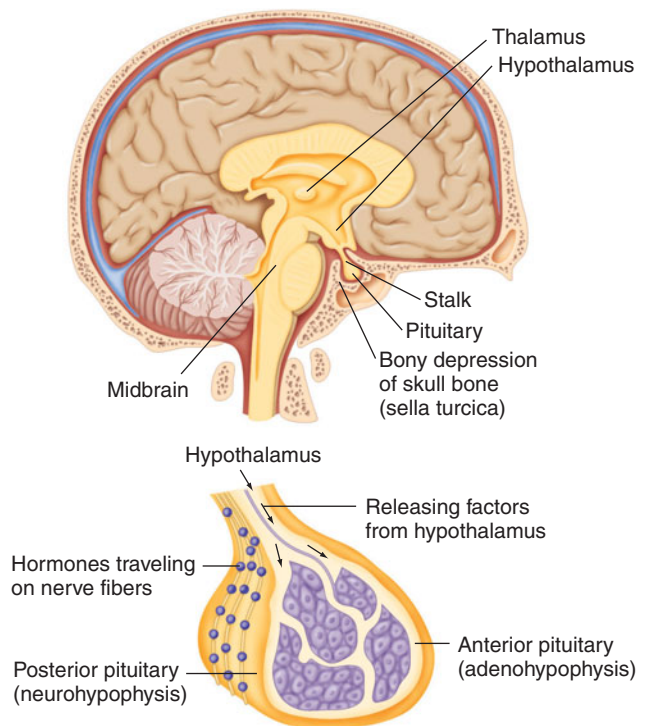


Figure 12-2 ► The pituitary gland.

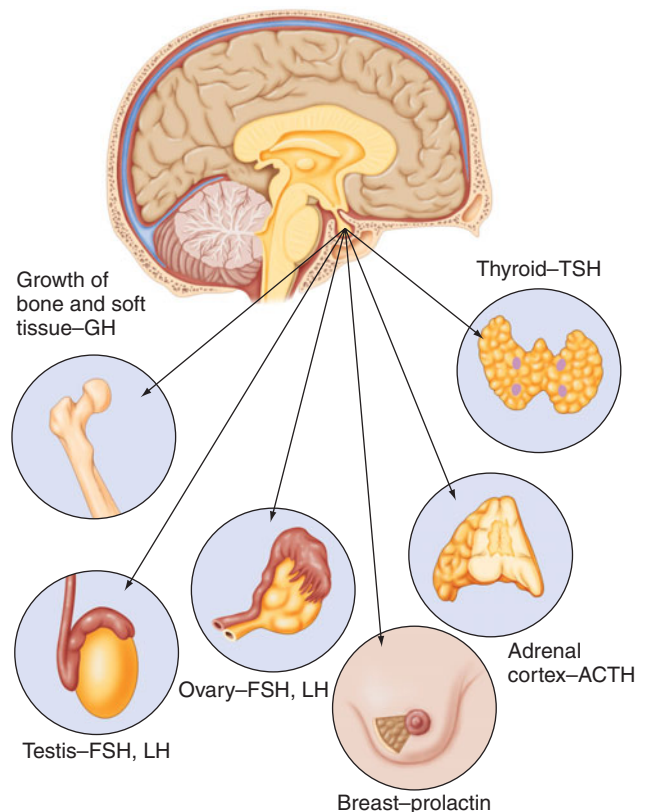


Figure 12-3 ► Anterior pituitary and its target organs.

Thyroid-Stimulating Hormone The anterior pituitary produces TSH, which controls hormone secretion by the thyroid gland. In general, in the absence of TSH, the thyroid gland stops functioning.

Adrenocorticotrophic Hormone The anterior pituitary also regulates the adrenal glands. The adrenal glands have an inner part, the adrenal medulla, and an outer portion, the adrenal cortex. ACTH produced by the anterior pituitary stimulates the release of adrenal cortex hormones.

Gonadotropins The anterior pituitary regulates sexual development and function by means of hormones known as the **gonadotropins**. The gonadotropins are follicle-stimulating hormone (FSH) and luteinizing hormone (LH). FSH stimulates egg and sperm production. LH stimulates the ovaries to produce estrogen and progesterone and stimulates the testes to produce testosterone. A surge in LH is the signal for ovulation.

Prolactin Prolactin produced by the anterior pituitary stimulates breast development and formation of milk during pregnancy and after delivery.

Hormones of the Posterior Pituitary

Antidiuretic Hormone ADH, also known as **vasopressin**, stimulates water absorption in the kidneys and therefore has an antidiuretic effect (depressing the formation of urine). Figure 12-4 ► illustrates the normal action of ADH. Figure 12-5 ► illustrates the effects of ADH deficiency (in which urine formation is increased).

Oxytocin The target organ of oxytocin is the smooth muscle of the uterus, where it stimulates uterine contractions; the mammary glands, where in response to suckling it triggers the release of milk from the breasts; and the prostate gland, where it causes ejection of prostate gland secretions.

Thyroid Gland

The thyroid gland is located in the neck region, one lobe on either side of the trachea, just below the thyroid cartilage (Adam's apple). A connecting strip, or isthmus, anterior to the trachea connects the two lobes (Figure 12-6 ►). The thyroid gland secretes thyroid hormone (TH), which is actually two iodine-containing hormones: **thyroxine** (T_4) and **triiodothyronine** (T_3). T_4 is the principle

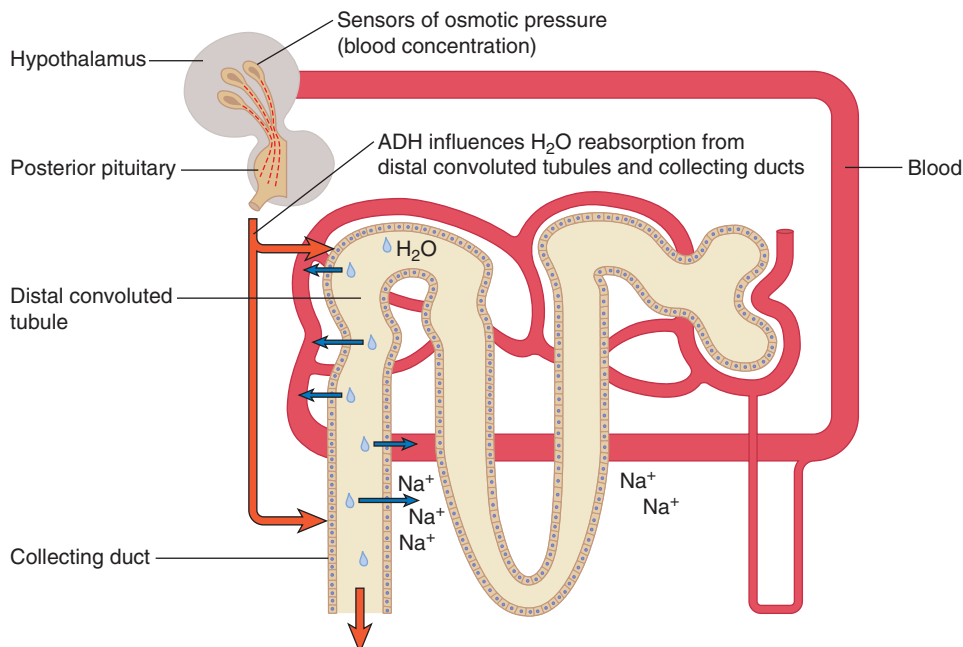


Figure 12-4 ► Normal action of antidiuretic hormone.

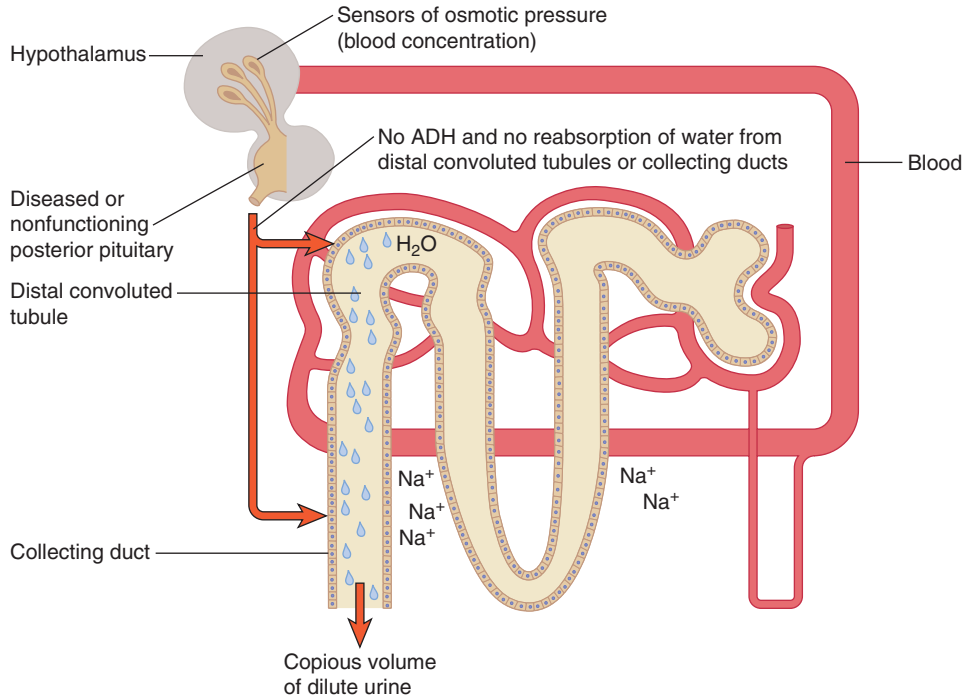


Figure 12-5 ► Effect of antidiuretic hormone deficiency.

thyroid hormone. A small amount of T_3 is produced by the thyroid gland; however, most T_3 is formed by conversion of T_4 to T_3 . TH affects virtually every cell in the body. See Table 12-2 ► for the major effects of thyroid hormone in the body.

As already noted, the anterior pituitary gland stimulates the thyroid by releasing TSH. The thyroid, in turn, releases TH, which circulates in the blood to all cells and tissues. When the level of circulating TH is high, the anterior

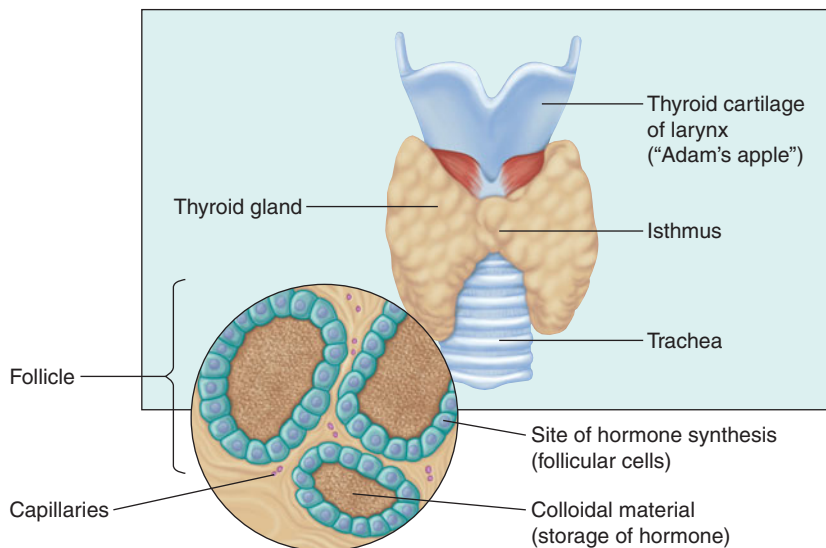


Figure 12-6 ► The thyroid gland.

TABLE 12–2 Major Effects of Thyroid Hormone in the Body

Process or system affected	Effect of thyroid hormone
Basal metabolic rate/temperature regulation	Increases basal metabolic rate and body heat production
Carbohydrate/lipid/protein metabolism	Promotes glucose catabolism; mobilizes fats; essential for protein synthesis; enhances synthesis of cholesterol by the liver
Nervous system	Promotes normal development of the nervous system in fetus and infants; promotes normal nervous system function in adults
Cardiovascular system	Promotes normal functioning of the heart
Muscular system	Promotes normal muscular development and function
Skeletal system	Promotes normal growth and maturation of the skeleton
Gastrointestinal system	Promotes normal gastrointestinal motility; increases secretion of digestive juices
Reproductive system	Promotes normal reproductive function in females
Integumentary system	Promotes normal hydration and secretory activity of skin

pituitary is inhibited and stops releasing TSH. This is an example of a negative-feedback mechanism. An adequate level of TH prevents further synthesis of the hormone. When the level of TH falls, the anterior pituitary is released from the inhibition and once again sends out TSH. This feedback mechanism is shown in Figure 12–7 ►.

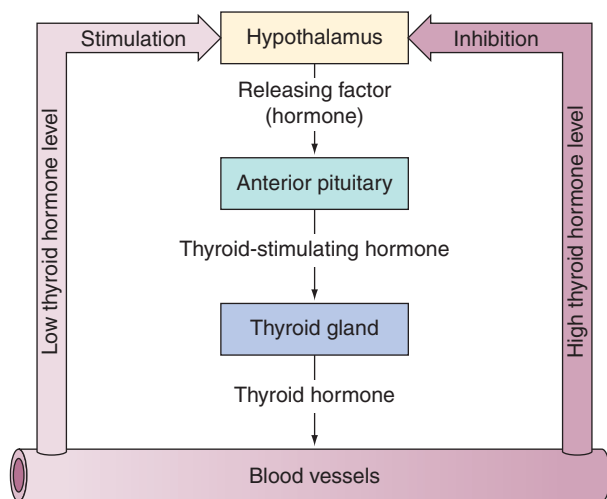


Figure 12–7 ► Control of thyroxine secretion through negative feedback.

Parathyroid Glands

The parathyroid glands are four tiny glands located posterior to the thyroid gland. Before the function of the parathyroid glands was understood, they were sometimes removed with a thyroidectomy. The hormone secreted by the parathyroids is **parathyroid hormone (PTH)**, also called parathormone (Figure 12–8 ►).

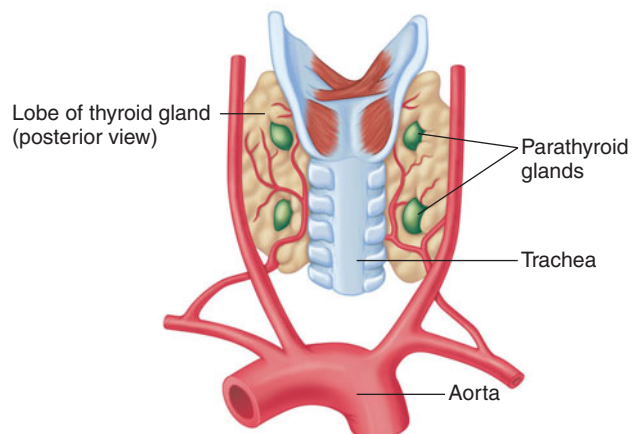


Figure 12–8 ► Parathyroid glands.

The parathyroid glands regulate the levels of circulating calcium and phosphate. Ninety-nine percent of the body's calcium is in bone, but the remaining 1% has many important functions. Calcium is essential to the blood-clotting mechanism, along with nervous conduction. It increases heart muscle tone and plays a significant role in muscle contraction.

PTH increases the concentration of calcium in blood by having the kidneys reabsorb calcium and not secrete calcium in urine. PTH also increases absorption of calcium by the intestines and increases the activity of osteoclasts, which break down bone and release calcium into the bloodstream.

Adrenal Glands

The adrenal glands are located on top of each kidney. Each of the glands consists of two distinct parts: an outer adrenal cortex and an inner adrenal medulla. The cortex and medulla secrete different hormones. The adrenal glands are shown in Figure 12-9 ►.

The adrenal cortex, which is stimulated by ACTH from the anterior pituitary gland, secretes many corticoids (corticosteroid hormones), which can be classified into three groups: the mineralocorticoids, the glucocorticoids, and the sex hormones. The **mineralocorticoids** regulate salt balance. The principal hormone of this group is aldosterone.

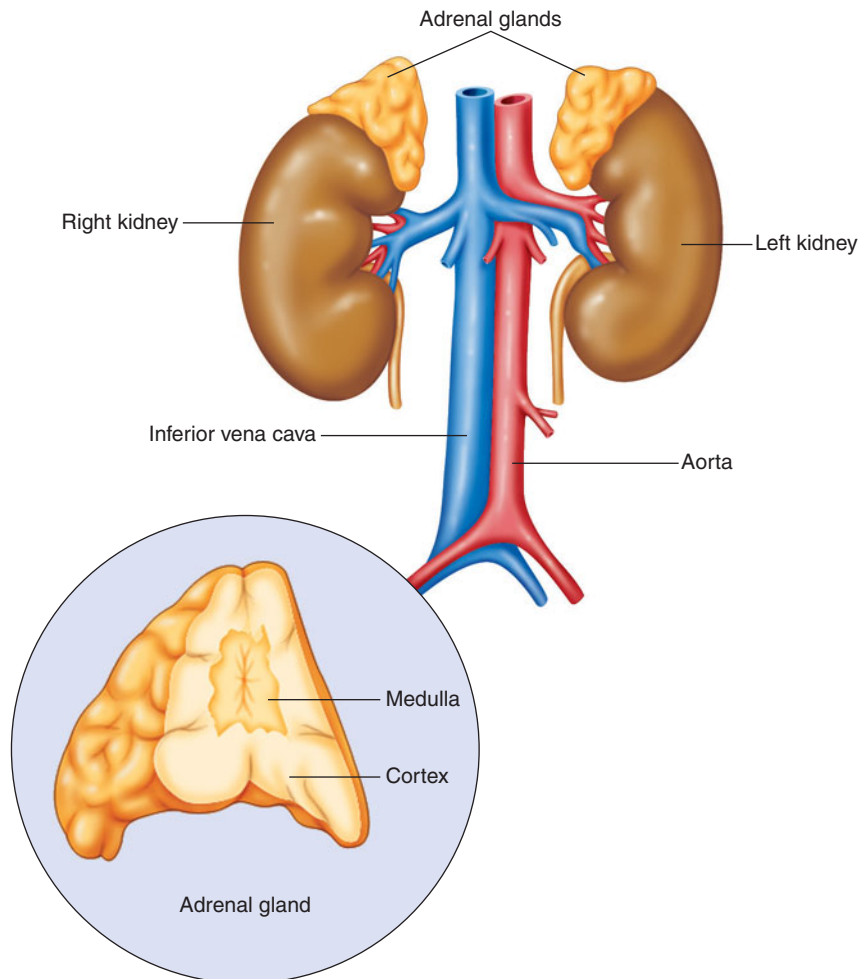


Figure 12-9 ► The adrenal glands.

Aldosterone causes sodium retention and potassium secretion by the kidneys. The **glucocorticoids** help regulate carbohydrate, lipid, and protein metabolism. The principal hormone of this group is **cortisol** or **hydrocortisone**. The sex hormones: **androgens**, the male hormones, and **estrogens**, the female hormones.

The adrenal medulla secretes **epinephrine**, commonly called **adrenalin**, and **norepinephrine**. These hormones are secreted in stress situations when additional energy and strength are needed. Epinephrine causes vasodilation and increases heart rate, blood pressure, and respiration. Norepinephrine brings about general vasoconstriction. Together, epinephrine and norepinephrine help shunt blood to vital organs when required.

Endocrine Pancreas

The pancreas is a fish-shaped organ that lies across the middle of the abdominal cavity, below the stomach. It is divided into a head, body, and tail, with the head nearest to the duodenum and the opening of the pancreatic duct. The endocrine functions of the pancreas consist of synthesis, storage, and release of **insulin**, **glucagon**, and **somatostatin**. Insulin is secreted by certain cells of the pancreas called **beta cells**, located in patches of tissue named the **islets of Langerhans** or **pancreatic islets**. Glucagon is secreted by the **alpha cells** of the islets. Somatostatin, secreted by **delta cells**, inhibits the secretion of glucagon and insulin.

Insulin and glucagon work antagonistically to each other. Insulin lowers the level of blood glucose, glucagon elevates it. The combined effect of these hormones maintains the normal level of blood glucose (80–120mg/dl). After a meal the blood sugar level rises, so insulin is secreted. Insulin moves sugar out of the blood and into tissues, thus decreasing the blood sugar level. Any carbohydrates that are not needed for immediate energy by the cells are stored, mostly in the liver, as glycogen. If the blood sugar level drops, for example after fasting or sleeping, glucagon is secreted. Glucagon stimulates the liver to release glycogen in the form of glucose, thus raising the blood sugar level. The control of glucose is illustrated in Figure 12–10 ►.

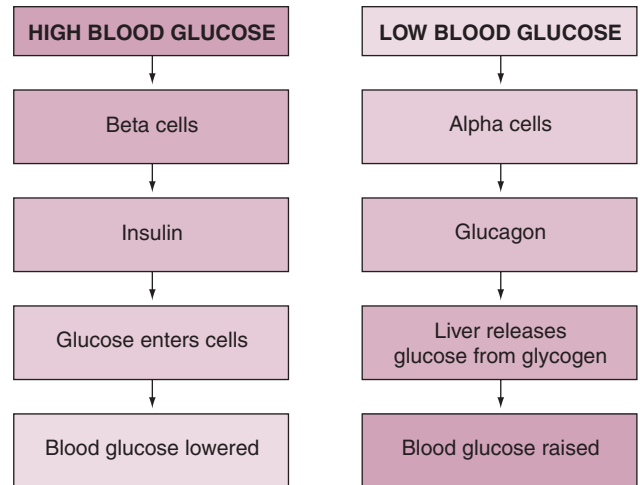


Figure 12–10 ► Control of blood glucose level.

Ovaries and Testes

The gonads (ovaries and testes) function as endocrine glands as well as being the source of the ova and sperm. Ova secrete estrogen and progesterone; the testes secrete testosterone. Estrogen and progesterone regulate sexual development, secondary sex characteristics, and the reproductive cycle in females. Testosterone regulates sexual development and secondary sex characteristics in males.

Diagnostic Tests and Procedures

Only the thyroid and testes can be physically examined. Hormone levels are measured in blood or urine samples via enzyme-linked immunosorbant assay (ELISA) and radioimmunoassay (RIA). In these assays of blood or urine samples, labeled hormone (antigen) in the sample competes with unlabeled hormone for binding sites on an antibody that is in limited availability. If there is a very high concentration of hormone in the blood or urine sample, most of the resulting antigen–antibody complexes will be unlabeled. If there is a very low concentration of hormone in the blood or urine sample, most of the antigen–antibody complexes will be labeled. Imaging tests can be used to locate glandular tumors. A biopsy is taken to determine if a tumor is malignant.

Diseases of the Pituitary

Anterior Pituitary Hyposecretion

Inherited disorders, malignant tumors, inadequate secretion of hormones, inflammation, and vascular changes of the pituitary gland can result in hyposecretion of the pituitary gland. The manifestations of hypopituitarism depend on which hormones are lost and the extent of the hormone deficiency.

Pituitary Dwarfism Pituitary dwarfism is due to inadequate secretion of growth hormone by the pituitary gland in children. An estimated 1 in 14,000 to 1 in 27,000 people have some type of dwarfism; pituitary dwarfism affects fewer than 200,000 people in the United States. Growth retardation becomes evident in infancy and persists throughout childhood. Normal puberty may or may not occur, depending on the degree to which the pituitary gland can produce sufficient hormone levels other than growth hormone.

Injury or trauma to the pituitary gland is the only known risk factor for pituitary dwarfism. Children with pituitary dwarfism are proportionately small. Signs and symptoms include slowed growth before the age of 5 years, absent or delayed sexual development, and short stature and height for age. In most cases the cause of pituitary dwarfism is idiopathic; other causes may include genetics, tumor in the pituitary gland interfering with hormone production, trauma to the gland, or radiation treatment to the head.

Diagnosis includes a blood test confirming low GH and imaging tests. GH replacement therapy is used to treat children with pituitary dwarfism. There is no known prevention except to prevent injury or trauma to the pituitary gland.

Anterior Pituitary Hypersecretion

Gigantism Gigantism is a result of hypersecretion of GH in children. There have been 100 cases of gigantism reported to date. There are no known risk factors for gigantism. In patients with gigantism, facial features may thicken, the hands and feet may be disproportionately enlarged, and headaches may develop along with excess sweating and late onset of puberty. With time,

joint problems occur, cardiovascular weakness and myopathy tend to develop, and there is a shorter life expectancy.

The most common cause of gigantism is a benign tumor of the pituitary gland that leads to excessive secretion of GH. Diagnosis includes physical examination, imaging tests, biopsy, and a blood test confirming high GH. Treatment of gigantism depends on the etiology of the growth hormone excess. In cases of well-defined tumors, surgery may be successful. Radiation therapy may be used in conjunction with surgery or in cases where surgery is not possible. Medications that reduce growth hormone secretion are also used for cases where surgery is not feasible. Prevention is not possible.

Acromegaly Acromegaly is the result of excess GH secretion in adulthood. Acromegaly prevalence is 4,676 cases per million people. There are no known risk factors for acromegaly. Acromegaly has an insidious onset, and signs and symptoms are usually present for a number of years before a diagnosis is made. The growth plates of the long bones are closed, so the long bones do not increase in length. Signs and symptoms may include enlargement of the hands, feet, and head; soft-tissue thickening of the palms of the hands and the soles of the feet; enlargement of the forehead; enlargement of the jaw that causes the teeth to spread; enlargement of the tongue; and arthritis.

Acromegaly is caused by a benign tumor of the pituitary gland that leads to excessive secretion of GH. Diagnosis is based on medical history, physical examination, a blood test confirming high GH, imaging tests, and biopsy. The treatment for acromegaly focuses on correcting metabolic abnormalities, improving adverse clinical features, and correcting the underlying cause. Surgical removal of tumors of the pituitary or hypothalamus is the treatment of choice. Medications that decrease growth hormone secretion may be administered prior to surgery or, in cases where surgery is not possible, to shrink the tumor. Radiation is also used to shrink the tumor and is used when medication therapy fails and in cases where surgery is not an option. Prevention is not possible; however, early treatment may reduce or prevent worsening of complications of this disorder.

Promote Your Health

Monitor Children's Growth

A number of endocrine disorders can result in impaired physical and mental development and growth. The effects of these disorders can be reduced in some cases by early

intervention with hormone therapy. Keep regular doctor appointments and monitor the growth of newborns, infants, and young children to identify problems early.

Posterior Pituitary Hyposecretion

Diabetes Insipidus Decreased secretion or action of ADH (vasopressin) results in diabetes insipidus (DI). The incidence of DI is 3 in 100,000. Risk factors include head injury, brain surgery, kidney disease, pregnancy, and taking certain medications (lithium, amphotericin B, demeclocycline). The chief symptom of diabetes insipidus is the production of abnormally large amounts of urine, or **polyuria**. Excessive urination is often accompanied by extreme thirst and a corresponding increase in fluid intake (**polydipsia**). Other signs and symptoms may include increased urinary frequency, disturbed sleep due to bedwetting, daytime fatigue, fever, headaches, weight loss, and low blood pressure.

There are two types of DI: central DI and nephrogenic DI. Central DI is usually caused by damage to the pituitary gland from surgery, a tumor, an illness (such as meningitis), inflammation, or a head injury. Nephrogenic DI occurs when there's a defect in the kidney tubules, making the kidneys unable to properly respond to ADH. The defect may be a genetic disorder or a chronic kidney disorder. Certain drugs, such as lithium and demeclocycline, also can cause nephrogenic DI.

The diagnosis of diabetes insipidus is based on medical history, physical examination, and a urinalysis and water restriction test. The urine of a DI patient will show colorless urine with a very low specific gravity (dilute urine). The water restriction test includes limiting the patient's water intake for several hours while measuring urine output, blood pressure, and urine concentration. After several hours, the patient is given vasopressin medication. If the medication decreases urine output and increases urine concentration, the DI diagnosis is confirmed. Imaging tests may assist in locating the etiology.

Treatment of diabetes insipidus is aimed at removing the primary cause and treating the symptoms to prevent dehydration. Diabetes insipidus may be controlled with vasopressin. Vasopressin is administered as either a nasal spray or tablets. Vasopressin is ineffective for nephrogenic diabetes insipidus. Treatment of nephrogenic diabetes insipidus requires compensatory fluid intake with effort to correct the underlying etiology. Kidney transplant may offer the best alternative if dialysis is insufficient or problematic. Prevention is not possible.

Diseases of the Thyroid Gland

Hypothyroidism

Hypothyroidism is a result of below-normal production of T_4 by the thyroid gland. The prevalence of hypothyroidism is 1–2% of the population. Risk factors for hypothyroidism include being female, being over age 50, having an autoimmune disorder, having a close relative with thyroid disease or an autoimmune disease, use of radioactive iodine, surgical removal of the thyroid gland, radiation to the head or neck, treatment with antithyroid medication, pregnancy, and some medications (lithium, interferon).

The signs and symptoms of hypothyroidism vary widely, depending on the severity of hormone deficiency. Common signs and symptoms may include unexplained weight gain; dry skin; hair loss; swollen face, hands, legs, ankles, or feet; increased sensitivity to cold; aches and pains in muscles or joints; hoarse or raspy voice; constipation; heavy or irregular menstrual periods; fatigue; slower thinking; trouble remembering things; slower speech; depression; enlarged thyroid; changes in blood cholesterol levels; slow heart rate; and infertility.

There are many things that can cause hypothyroidism. Common causes of hypothyroidism include autoimmune diseases (Hashimoto's disease), surgery to remove all or part of the thyroid, radiation treatment, treatment for hyperthyroidism, and certain medications (lithium, interferon). Diagnosis is based on medical history, signs and symptoms, blood test confirming low T_4 and T_3 and high TSH, autoantibody testing, and imaging tests. Hypothyroidism is treated with thyroid hormone replacement therapy, usually for the rest of the patient's life. Hypothyroidism is not preventable.

Congenital Hypothyroidism

Hypothyroid of the newborn, also known as cretinism, occurs in 1 in 4,000 newborns. There are no known risk factors for congenital hypothyroidism. Signs and symptoms may include umbilical hernia and a protruding abdomen, a reduced level of activity and generalized lethargy, continuous weight gain even with poor feeding habits, small stature, retardation of physical growth, developmental delay, swelling in the eyelids, enlarged tongue, and coarse facial features.

Congenital hypothyroidism is most often the result of **hypoplasia** (underdevelopment), **aplasia** (absence of development), and failure of the thyroid gland to migrate to its normal anatomical position. Maternal factors such as an iodine deficiency and ingestion of antithyroid medications during pregnancy can cause hypothyroidism in both the mother and the fetus.

Congenital hypothyroidism is diagnosed by blood test confirming low levels of T_3 and T_4 and high TSH, usually within the first 10 days of birth. Adequate treatment with thyroid hormone supplementation started as soon as possible improves the prognosis of intellectual development and function later in life. Congenital hypothyroidism is not preventable.

Hyperthyroidism

Hyperthyroidism is a condition of thyroid hormone excess. **Graves' disease** is the most common form of hyperthyroidism. The prevalence of Graves' disease is 0.4% of the population. Graves' disease is more common in women than in men. The onset of Graves' disease is between

the ages of 20 and 40 years, and it is often associated with autoimmune diseases such as diabetes mellitus and rheumatoid arthritis. Risk factors are being female, family history, stress, and smoking.

Signs and symptoms of Graves' disease include enlargement of the thyroid, nervousness, irritability, heat intolerance, increased sweating, insomnia, rapid or irregular heartbeat, fatigue, diarrhea, and weight loss. About half the people with Graves' disease have Graves' ophthalmopathy or bulging eyes. A sudden increase in severity of signs and symptoms may signal thyrotoxicosis (thyroid storm) from very high thyroid hormone levels, which can be life-threatening. Diagnosis is based on family history, physical exam, signs and symptoms, blood test confirming high T_3 and T_4 and low TSH, and imaging.

Graves' disease is caused by an abnormal immune system response that causes the thyroid gland to produce too much thyroid hormone. The immune system releases abnormal antibodies that mimic TSH, and thereby thyroid hormone production is increased. Treatment of hyperthyroid disease depends on the severity, etiology, and presence of complications. The goal of treatment is to bring the metabolic rate to normal with minimal complications. Medications, radioactive iodine, and surgery are used to treat hyperthyroidism. Drugs that inhibit the formation of thyroid hormone are administered until thyroid function returns to normal. If thyroid levels cannot be maintained, radiation or surgery may be performed. Medications that control heart rate and blood pressure are administered to prevent complications of thyrotoxicosis. Prevention is not possible.

Simple Goiter

Goiter is an enlargement of the thyroid gland (Figure 12-11 ►). The number of people with simple goiter is not known. Risk factors for simple goiter include being female, over age 40, and having a family history of goiter. The extent of thyroid gland enlargement varies. Thyroid enlargement can compress the trachea or esophagus, causing difficulty breathing or swallowing, dizziness, and syncope. Simple goiter may be caused by an iodine deficiency, eating a large amount of goiter-producing foods (soy, peanuts,



Figure 12–11 ► A patient with goiter due to iodine deficiency. (Centers for Disease Control and Prevention)

peaches, spinach, turnips, cabbage, Brussels sprouts, seaweed) that inhibit the production of TH, certain medications (immunosuppressants, antiretrovirals, lithium), or it may be idiopathic. Diagnosis includes medical history, physical examination, blood test to measure levels of TH and TSH, and imaging tests. Treatments for an enlarged thyroid include thyroid hormone replacement pills if the goiter is due to an underactive thyroid, small doses of iodine if the goiter is due to a lack of iodine, radiation therapy to shrink the gland if the thyroid is producing too much thyroid hormone, and surgery to remove all or part of the gland. Prevention includes adequate intake of dietary iodine and monitoring intake of goiter-producing foods and medication.

Thyroid Cancer

Thyroid cancer is cancer that starts in the thyroid gland. The American Cancer Society estimates in 2013 there will be 60,220 new cases of thyroid cancer and 1,850 deaths due to thyroid cancer. Thyroid cancer is commonly diagnosed at a younger age than most other adult cancers. Nearly two out of three cases are found in people younger than 55 years of age. Risk factors for

thyroid cancer include being female, a diet low in iodine, and exposure to radiation. Thyroid cancer does not usually cause signs or symptoms early in the disease. As the tumor grows, signs and symptoms may include a lump in the neck, voice hoarseness, difficulty swallowing, pain in the neck and throat, and swollen lymph nodes in the neck. The cause of thyroid cancer is not known. Diagnosis may include medical history, physical examination, blood tests to measure levels of TSH and TH, imaging tests, and biopsy. Treatment may include surgery, radioactive iodine treatment, thyroid hormone therapy, radiation therapy, chemotherapy, and targeted therapy. Thyroid cancer is not preventable.

Diseases of the Parathyroid Gland

Hyperparathyroidism

Hyperparathyroidism results from excessive secretion of parathyroid hormone by the parathyroid glands. The overall prevalence in the general population is about 3 in 1,000 but may be up to 21 in 1,000 in postmenopausal women. Hyperparathyroidism occurs most frequently in persons over the age of 50 years and is about three times more common in women than in men. Risk factors include being postmenopausal, chronic vitamin D deficiency, neck area radiation, and lithium therapy.

Excessive parathyroid hormone raises the level of circulating calcium above normal, a condition called **hypercalcemia**. Much of the calcium comes from bone reabsorption mediated by parathyroid hormone. As the calcium level rises, the phosphate level falls, and various risk conditions develop. With the loss of calcium, the bones weaken, tend to bend, and fracture spontaneously. Giant cell tumors and cysts of the bone may develop. Excessive calcium causes formation of kidney stones because calcium forms insoluble compounds. Calcium deposited within the walls of the blood vessels makes them hard. Calcium deposits may also be found in the stomach and lungs.

Hyperparathyroidism, with its concurrent excess of calcium, causes generalized signs and symptoms. There may be pain in the bones

that is sometimes confused with arthritis. The nervous system is depressed, and muscles lose their tone and weaken. Heart muscle is affected, and the pulse slows. Signs and symptoms include gastrointestinal disturbances, abdominal pain, vomiting, and constipation. These signs and symptoms result from deposits of calcium in the mucosa of the gastrointestinal tract. Other deposits of calcium may form in the eye, causing irritation and excessive tearing. Hyperparathyroidism is often caused by benign tumors of the parathyroid, causing oversecretion of PTH. The size of the tumor often correlates with the amount of parathyroid hormone secreted into the blood. Diagnosis includes blood test to confirm high PTH and calcium and low phosphorous; urinalysis confirming increased calcium, and imaging tests.

Treatment of hyperparathyroidism depends on the etiology. Surgery to remove a tumor or removal of the parathyroid glands might be necessary. Other treatments may include diuretics to increase urine output, thus increasing calcium excretion, and limiting the intake of calcium. Treatment is aimed at lowering serum calcium level. There is no known prevention for hyperparathyroidism.

Hypoparathyroidism

Hypoparathyroidism is the result of a decrease in secretion of parathyroid hormone by the parathyroid glands. Prevalence in the United States is about 4 in 1,000. Risk factors include damage to the glands from heavy metals (copper or iron) or immune disorders (Addison's disease), a family history of hypoparathyroidism, and some infections.

The principal manifestation of hypoparathyroidism is **tetany**, a sustained muscular contraction. In hypoparathyroidism, the muscles of the hands and feet contract in a characteristic fashion. The typical tetanic contraction of the hand is seen in Figure 12-12 ►. Signs and symptoms of chronic hypoparathyroidism may include lethargy, personality changes, anxiety, blurred vision, and trembling of the limbs.

Hypoparathyroidism is usually a transient condition that commonly occurs in patients following surgical removal of the thyroid gland. Diagnosing includes physical examination,

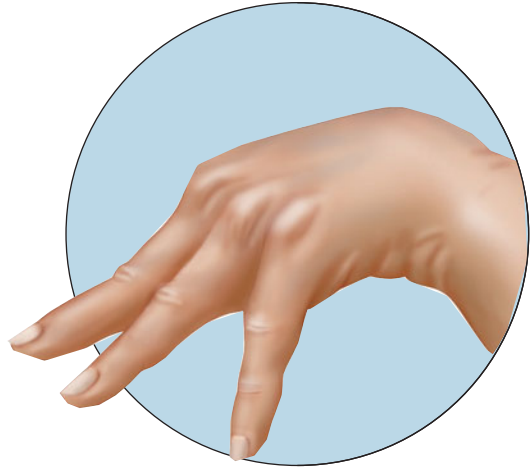


Figure 12-12 ► Tetany of the hand in hypoparathyroidism.

blood test confirming low PTH and calcium and high phosphate, electrocardiogram, and imaging tests. Hypoparathyroidism is treated with calcium and vitamin D.

Diseases of the Adrenal Glands

Diseases of the Adrenal Cortex

Hypoadrenalism Primary adrenal insufficiency, or **Addison's disease**, is the result of undersecretion of hormones by the adrenal cortex. Addison's disease was first described in 1855 when Thomas Addison described symptoms associated with destruction of the adrenal glands. The prevalence of Addison's disease is rare, occurring in approximately 1 in every 1,000 people. It is more common in females, with a female-to-male ratio of 2:1, and is usually diagnosed in the third to fifth decades of life. Having other autoimmune problems such as Graves' disease, hypopituitarism, and vitiligo is a risk factor for Addison's disease.

The lack of cortisol, aldosterone, and adrenal androgens contribute to the symptoms of Addison's disease. Weight loss, fatigue, and anorexia occur with a deficiency in cortisol. The most distinctive sign is hyperpigmentation found in non-sun-exposed areas of the body such as the gingival tissues and in the creases of the palms of the hands. Gastrointestinal signs and symptoms include anorexia or loss of appetite, abdominal discomfort, vomiting, and diarrhea.

Fluid loss from these symptoms may contribute to low blood pressure or hypotension, and thus is often associated with dizziness, lack of blood sodium, and **syncope**, or fainting.

Addison's disease can result from any disease process that damages the entire adrenal cortex; however, approximately 75–80% of all cases are due to an autoimmune process. Other common causes of adrenal insufficiency are infectious diseases such as tuberculosis, fungal disease, opportunistic infections associated with AIDS, certain cancers, and hemorrhage of the adrenal gland secondary to anticoagulation medication.

Diagnosis is based on medical history, physical examination, and blood tests confirming low cortisol and high ACTH, ACTH stimulation test that measures the level of cortisol before and after an injection of synthetic ACTH, and imaging tests.

Addison's disease can cause a life-threatening condition known as acute adrenal insufficiency, especially in patients with chronic adrenal insufficiency who also have another acute illness such as infection, trauma, or severe physical stress such as surgery. Symptoms develop rapidly and include nausea, vomiting, abdominal pain, and severe hypotension. Death can result from shock and cardiovascular collapse. Treatment requires immediate rehydration with salt solutions and intravenous glucocorticoid replacement.

The treatment of Addison's disease includes lifelong replacement of both glucocorticoids and mineralocorticoids. During stress, patients may require additional medication such as hydrocortisone, because these patients are not able to increase endogenous cortisol production. Addison's disease is not preventable.

Hyperadrenalism Hyperadrenalism can be due to an overproduction of cortisol (**Cushing's syndrome**), or an overproduction of aldosterone (**Conn's syndrome**). Cushing's syndrome is discussed first.

The prevalence of Cushing's syndrome is approximately 1 in every 500,000 people. Risk factors include having an adrenal tumor or corticosteroid therapy. Classic signs of Cushing's syndrome include fat accumulation behind the shoulders, known as a buffalo hump, and a round "moon-shaped" face (Figure 12–13 ►). Other signs and symptoms may include fatigue, weakness, impaired wound healing, protruding abdomen, hypertension, weight gain, and stretch marks on the skin.

The etiology of Cushing's syndrome is most often a benign pituitary tumor. Other causes include adrenal tumors that cause excessive secretion of cortisol. Prolonged administration of large doses of cortisone will also cause Cushing's syndrome. Diagnosis includes a blood and



A



B

Figure 12–13 ► A patient with Cushing's syndrome (A) before and (B) after receiving treatment. (Sharmyn McGraw)

urine test to confirm high levels of cortisol and imaging tests.

The goal of treatment for Cushing's syndrome is to correct hypersecretion of adrenal hormones. Removal of pituitary tumors is accomplished through surgery or radiation therapy. Medications that block the synthesis of corticosteroids are useful in patients who cannot have surgery. Cushing's syndrome is not preventable; however, Cushing's syndrome related to cortisone treatment is preventable by carefully monitoring patients for signs and symptoms of Cushing's syndrome.

The prevalence of Conn's syndrome is 0.05–2.0%. Women are twice as likely as men to suffer from Conn's syndrome and the incidence increases with age. There are no known risk factors for Conn's syndrome. Hypertension is often the only sign. The hypertension may cause headaches, blurred vision, and dizziness. While patients with hyperaldosteronism may have normal potassium levels, many patients may have low potassium levels. The hypokalemia (low potassium level) can cause symptoms such as fatigue, numbness, increased urination, increased thirst, muscle cramps, and muscle weakness. Hyperaldosteronism leads to an increased risk for heart attack, heart failure, stroke, kidney failure, and early death. Conn's syndrome most often results from a benign tumor of the adrenal cortex. Diagnosis includes a blood test to confirm a high level of aldosterone and a low or undetectable level of rennin, which is produced by the kidneys, and imaging tests. Treatment includes surgery, antihypertensive medication, and aldosterone blockers. Conn's disease is not preventable.

Hyposecretion of the Pancreas

Diabetes Mellitus (Hyperglycemia)

Diabetes mellitus (DM) is an endocrine disease of impaired glucose regulation and **hyperglycemia** caused by complex interactions of genetics, environmental factors, and lifestyle choices. Depending on the underlying etiology of DM, factors contributing to hyperglycemia may include an absolute insulin deficiency, reduction in insulin secretion, decreased glucose utilization, and increased glucose production. The prevalence of DM is 8.3% of the population.

Type 1 Diabetes **Type 1 diabetes mellitus (T1DM)** is characterized by little or no insulin production. Type 1 diabetes accounts for approximately 5–10% of all diabetes cases. This type of diabetes was formerly known as “juvenile-onset diabetes,” as the peak incidence of this disease is between the ages of 10 and 14 years. Risk factors for T1DM include genetics, a family history of T1DM, certain viral infections, being Caucasian, living in a northern climate, and having other autoimmune diseases.

Signs and symptoms of T1DM include **polyuria** (excessive urination), **polydipsia** (excessive thirst), and **polyphagia** (excessive hunger and weight loss). Because of water's movement by concentration gradients, water is lost through the kidneys as glucose concentrations rise. To compensate for fluid loss, patients develop extreme thirst. Although blood glucose levels are high, the body's tissues are unable to take up the glucose and use it effectively as an energy source because of the lack of insulin. Patients develop extreme hunger in the presence of hyperglycemia, leading to excessive eating with a paradoxical weight loss. Patients experience rapid weight loss despite increased food intake.

T1DM occurs when an autoimmune process develops in individuals who are genetically susceptible and exposed to some unknown environmental trigger. In T1DM, the immune system attacks and destroys beta cells. This destruction typically occurs over several months, although it may be more rapid or last for years. Once 80% or more of beta cell function is destroyed, patients no longer have sufficient insulin capacity to control blood glucose, so they develop the hyperglycemia of diabetes. Eventually, patients lose the ability to produce insulin and depend on insulin injections to survive.

T1DM diagnosis may include a number of tests. A urine test can show the presence or absence of glucose in the urine. Fasting blood glucose levels, glucose tolerance testing, and glycosylated hemoglobin testing are used to monitor and diagnose diabetes. For the fasting blood glucose level test, a sample of blood is taken after the person has fasted for 8 hours. The glucose tolerance test challenges the body's ability to secrete and use insulin. The test is performed after a 10-hour fast. The patient drinks a standard glucose solution, and blood and

urine samples are taken and analyzed for the next 3 hours. No glucose should appear in the urine, and the blood glucose levels should not exceed 170 mg/dL of blood if insulin is being produced and utilized. Glycosylated hemoglobin determination is a simple blood test that is used to monitor long-term control of diabetes. It generally indicates the average blood glucose levels over the past 90 days. Normal values should be below 6, and levels for diabetics should be less than 7.

Treatment includes taking insulin, exercising regularly, maintaining a healthy weight, eating a healthy diet, and monitoring blood sugar. There is no known way to prevent T1DM.

Type 2 Diabetes In **type 2 diabetes mellitus (T2DM)** the body resists the effects of insulin or does not produce enough insulin to maintain a normal glucose level. Type 2 diabetes accounts for 90–95% of diabetic cases. Risk factors for the development of T2DM include a family history of diabetes, being over age 45, obesity, history of gestational diabetes, sedentary lifestyle, and history of high blood pressure and high cholesterol, or hyperlipidemia. Signs and symptoms of T2DM include polyuria, polydipsia, polyphagia, weight loss, fatigue, blurred vision, numbness or tingling in the hands or feet, and slow wound healing.

The cause of T2DM is unknown, although excess weight and physical inactivity seem to be contributing factors. Diagnosis includes urine testing and blood glucose testing. Treatment of T2DM includes blood sugar monitoring, healthy

eating, regular exercise, and possibly diabetes medication or insulin therapy. Diabetes medications increase the body's sensitivity to insulin and lower glucose production in the liver or stimulate the pancreas to produce and release more insulin. People at risk for T2DM can prevent or delay developing T2DM by losing weight and exercising. Table 12–3 ► compares T1DM and T2DM.

Gestational Diabetes Diabetes may develop during pregnancy, a condition called **gestational diabetes**. Resistance to the effects of insulin is related to the metabolic changes of pregnancy associated with increased requirements for insulin. Gestational diabetes occurs in approximately 4% of pregnancies. Risk factors for gestational diabetes include being over age 25, family history of T2DM, personal history (prediabetes, gestational diabetes, giving birth to a baby weighing more than 9 pounds, unexplained stillbirth), and being overweight.

For most women gestational diabetes does not cause signs or symptoms. Rarely, gestational diabetes may cause excess thirst or increased urination. The etiology of gestational diabetes is unknown. Hormones produced by the placenta during pregnancy lead to higher blood glucose levels. Usually the mother's pancreas is able to make more insulin to overcome the effect of pregnancy hormones on blood sugar levels. If, however, the pancreas cannot produce enough insulin to overcome the effect of the increased hormones during pregnancy, blood sugar levels will rise, resulting in gestational diabetes.

TABLE 12–3 Comparison of Type 1 Diabetes to Type 2 Diabetes

	Type 1 diabetes	Type 2 diabetes
Age at onset	Usually children/teens	Mostly adults but an increasing number of children are being diagnosed
Prevalence	5–10% of diabetics of the United States	90–95% of diabetics in the United States
Etiology	Beta cells in the pancreas are attacked by the patient's immune system. Patient no longer has sufficient insulin capacity to control blood glucose levels.	Patient is less sensitive to insulin
Prevention	Cannot be prevented	Healthy lifestyle including maintaining a healthy weight, eating sensibly, and exercising regularly

Gestational diabetes is diagnosed via the oral glucose tolerance test. Treatment for gestational diabetes includes monitoring blood sugar, eating a healthy diet, getting regular physical activity, and possibly diabetes medication or insulin therapy. Most women revert to normal glucose tolerance following pregnancy but continue to have a considerable risk for developing diabetes later in life. There are no guarantees when it comes to preventing gestational diabetes but eating a healthy diet, being physically active, and losing excess weight before getting pregnant may help.

Complications of Diabetes Mellitus Sugar is the primary energy source for cells. When glucose is not available, cells will use protein and fat as their energy source and produce a waste product called ketones. Ketones in the blood, breath, and urine is called ketosis. Ketones are acidic, which produces acidosis or low pH in the tissues. Because of this, ketosis is often called ketoacidosis. Ketones make the breath of affected individuals smell fruity.

Life-threatening complications of T1DM include diabetic coma and insulin shock. Both of these complications are a result of improper insulin administration, either too much or not enough insulin. Diabetic coma is the result of not administering enough insulin or eating too many carbohydrates. Signs and symptoms develop slowly and include polyuria, polydipsia, dehydration, and ketoacidosis. The affected individual becomes lethargic and, if not treated, falls into a coma. The person will have slow, deep breathing and fruity breath. Emergency medical treatment with insulin is needed.

Insulin shock is the result of administering too much insulin, not eating enough food, or participating in excessive exercise. Signs and symptoms come on quickly and include low blood sugar, sweating, lightheadedness, and trembling. Without treatment the affected individual will become confused and then fall into a coma. Emergency medical treatment with intravenous glucose is needed.

Hyperosmolar hyperglycemic state typically occurs in older, debilitated patients with type 2 diabetes. Similar to DKA, HHS is associated with acute stress from infections, medical illnesses, or surgery. Because T2DM patients have some insulin function, ketone body formation is

prevented; however, patients often present with hyperglycemia in the range of 250–400 mg/dL. Treatment of HHS is aimed at rehydration and correction of hyperglycemia and electrolyte disturbances. Aggressive intravenous fluid and electrolyte replacement is necessary as patients can lose up to 10 liters, or 2.5 gallons, of fluid within a short period of time. Administration of intravenous insulin is essential to improve glucose utilization and correct the hyperglycemia.

Chronic complications of diabetes are due to chronic pathological insults to the microvasculature, or small blood vessels, and to the macrovasculature, or large vessels. Microvascular disease occurs primarily in the eyes, kidneys, and nerves. Hyperglycemia damages the endothelial cell lining of blood vessels, resulting in progressive narrowing and occlusion of large and small vessels. Cells die when vessel occlusion cuts off blood supply. Macrovascular damage leads to cardiovascular disease, the leading cause of death in patients with diabetes.

Microvascular disease of diabetes includes retinopathy, nephropathy, and neuropathy. Diabetic retinopathy is the leading cause of blindness among adults age 20–74 years. Diabetic nephropathy occurs in approximately 20–30% of patients with diabetes and is the leading cause of end-stage kidney disease. About 60–70% of patients with diabetes have nerve damage or neuropathy. Typical symptoms of neuropathy include numbness or tingling in the hands and feet and or severe, burning muscle aches. The loss of sensation in the feet and poor circulation can lead to severe infections requiring amputations. More than 60% of nontraumatic limb amputations in the United States occur annually in people with diabetes.

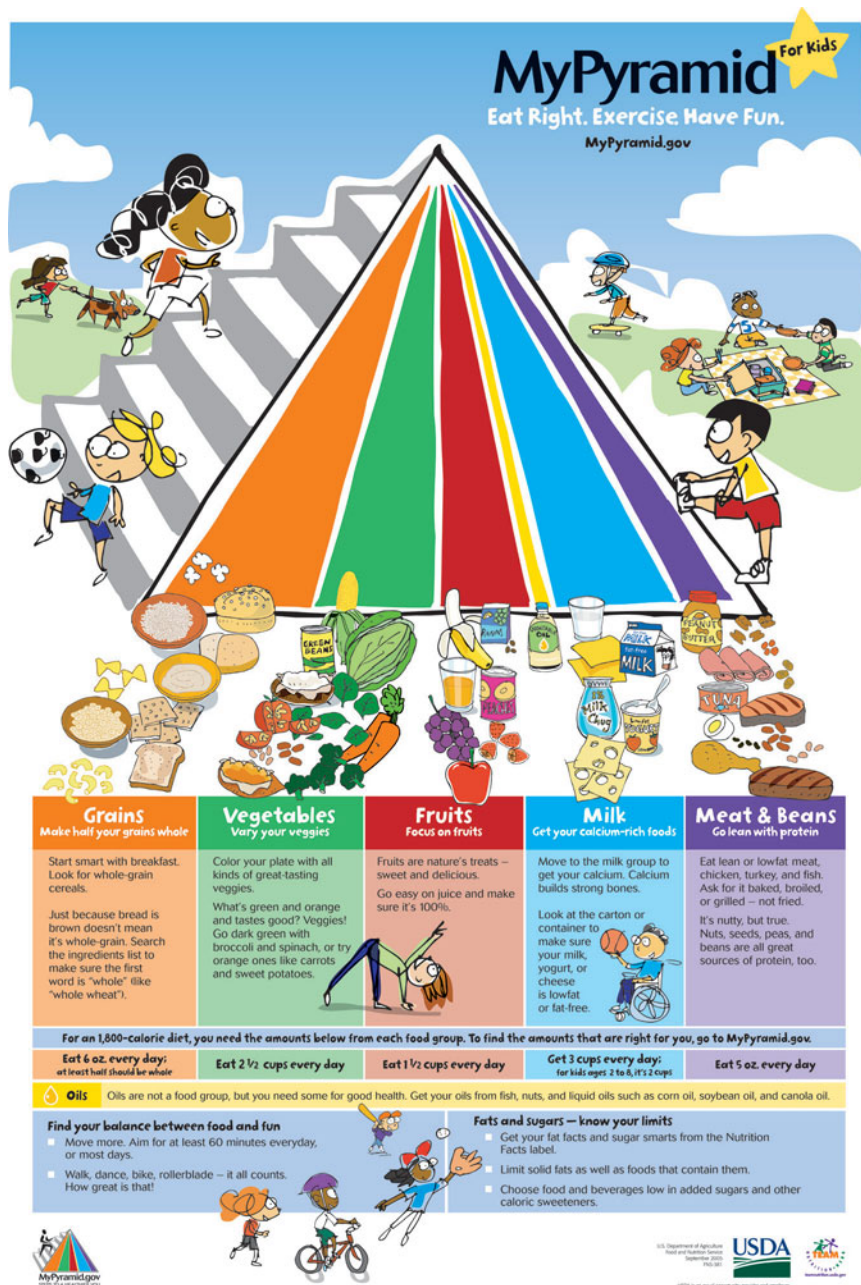
Education of the Diabetic Patient The American Diabetes Association, physicians, nurses, and dietitians have made a great effort to assist the diabetic patient in leading a normal life. The diabetic who understands the disease knows the importance of weight control, diet, exercise, and either insulin or oral agents in leading a normal life. A safety precaution advised by the American Diabetes Association is that anyone who takes insulin should carry an identification card explaining the emergency treatment required if an insulin reaction occurs.

Prevention PLUS!

Obese Children and Type 2 Diabetes

The number of overweight children is increasing in the United States. Obese children are at increased risk of developing Type 2 diabetes mellitus as young adults. They also have an increased lifetime risk for heart disease and

cancer. These chronic diseases are largely preventable through proper diet, weight control, and adequate exercise appropriate for age; see the "MyPyramid for Kids" diagram.



Source: http://teamnutrition.usda.gov/resources/mpk_poster2.pdf

Prevention PLUS!

Diabetes Control

Control of blood sugar significantly reduces the risk for developing complications of diabetes. Nearly three-fourths of adults with diabetes lack basic information that can help control their disease. Studies have shown that better control of diabetes helps prevent serious complications that may develop over time. Here are some tips to help control blood sugar:

Keep your blood glucose within your goal range as much as possible. Work with your diabetes team to develop and maintain a plan.

Take your diabetes medication as prescribed. If you're on insulin, ask to see a diabetes educator to learn how to adjust your dose.

Increase physical activity. If you aren't physically active, talk to your health care provider about suitable activities.

If you haven't exercised in a while, consider beginning with 5–10 minutes of daily physical activity and gradually increase your activity to at least 30 minutes of physical activity most days of the week.

Achieve and maintain a healthy weight. Even a 5–7% weight loss will help you better manage your blood glucose.

Think Critically

1. How many minutes of daily physical activity do you need to do most days of the week?
2. True or false: A 5% weight loss will help you better manage your blood glucose level?

Research suggests that weight loss surgery can reverse and possibly cure Type 2 diabetes. With more than a third of the American population obese, and more than 8% having diabetes, which contributes greatly to heart, vascular, and kidney disease, this new approach holds promise for millions.

Abnormalities in Secretion of Sex Hormones

Hypergonadism

Hypergonadism is the result of increased hormone production before puberty by the gonads, which produces precocious puberty in both sexes. In a male child, precocious puberty is defined as the onset of puberty before the age of 9. In a female child, precocious puberty is defined as the onset of puberty before the age of 8.

Precocious puberty currently affects 1 in 5,000 children and is 10 times more common in girls than in boys. Risk factors include being a girl, obesity, being exposed to sex hormones, and having other medical conditions (congenital adrenal hyperplasia, hypothyroidism). Signs and symptoms of precocious puberty in both boys and girls may include pubic or underarm hair, rapid growth, acne, and adult body odor.

Signs and symptoms in girls may include breast development and first menstruation. Signs and symptoms in boys may include enlarged testicles and penis, facial hair, and voice deepening.

For the majority of girls, the etiology of precocious puberty is idiopathic. Uncommon causes include ovarian and adrenal tumors; however, hypersecretion of ovarian hormones in the female is rare because negative-feedback stimulation of gonadotropic hormones stops ovarian hormone secretion. In boys precocious puberty is idiopathic; it may be caused by a tumor in the testes or the pituitary gland. Diagnosis may include a review of the child's and family's medical history, physical exam, and blood tests to confirm elevated levels of sex hormones.

Treatment depends on the cause of precocious puberty and may include removal or radiation of tumors and medications to suppress or counteract the sex hormones. There is no known prevention for hypergonadism.

Age-Related Diseases

Some changes in endocrine function occur normally with aging. Of these, none are significant causes of disease. However, some changes make the aging person more susceptible to disease.

Growth hormone level decreases with age. This is manifested in men after age 30 as a decrease in lean body mass and decreases in thickness and strength of bone matrix. As the body fat level increases, the growth hormone level decreases further. Increased body fat is correlated with greater risk of diabetes, heart disease, and cancer. Decreased bone density makes bones more susceptible to fracture.

A slight decrease in $T_3:T_4$ ratio is seen with age, resulting in decreased metabolic rate. The incidence of autoimmune disease of the thyroid among females increases with age.

Although aldosterone levels remain relatively steady, an age-related decline in the kidneys' sensitivity to aldosterone occurs, accompanied by a diminishing capacity of the kidneys to secrete renin when needed. The body is less able to deal with the stress of changes in blood pressure, dehydration, and disease in general. There is an increased incidence of abnormalities in blood pressure, sodium and potassium levels, acid-base balances, and osmotic pressure.

The pancreas retains the ability to secrete insulin at normal levels with age, but tissue

responsiveness to insulin decreases. Insulin resistance leads to a greater incidence of T2DM. It is estimated that T2DM occurs in 10% of those over age 56, in 20% of those between 45 and 76, and in 40% of people over age 85. Although T1DM is somewhat less common than T2DM, and its occurrence is unrelated to aging, it remains among the 10 leading causes of death among people over age 65.

Androgen and estrogen levels drop with age, although this is considered a normal process of aging.

Resources

- Acromegaly: www.acromegaly.org
- American Diabetes Association, Diabetes Facts and Figures: www.diabetes.org/diabetes-statistics.jsp
- Cesario SK, Hughes LA. Precocious Puberty: A Comprehensive Review of Literature. *Journal of Obstetrics and Gynecology Neonatal Nursing* 2007;36(3):263–274.
- Congenital hypothyroidism: www.congenitalhypothyroidism.net
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- National Diabetes Information Clearinghouse (NDIC): www.diabetes.niddk.nih.gov
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Healthy Aging

Bone Health

With aging comes a natural loss of bone due to many endocrine changes. You can slow the bone loss by ensuring a good dietary intake of calcium. Stay active with weightbearing exercise to maintain strong bones and reduce the risk for osteoporosis and fractures.

Diseases at a Glance

Endocrine System

Disease	Etiology	Signs and Symptoms
Pituitary dwarfism	Idiopathic, genetics, tumor in the pituitary gland, trauma to the gland, radiation treatment to the head	Slowed growth before the age of 5 years, absent or delayed sexual development, and short stature and height for age
Gigantism	Benign tumor of the pituitary gland	Facial features may thicken and the hands and feet may be disproportionately enlarged, headaches may develop along with excess sweating and late onset of puberty. With time joint problems occur; cardiovascular weakness and myopathy tend to develop.
Acromegaly	Benign tumor of the pituitary gland	Enlargement of the hands, feet, and head; soft tissue thickening of the palms of the hands and the soles of the feet; enlargement of the forehead and jaw, causing the teeth to spread; enlargement of the tongue; arthritis
Diabetes insipidus	Central DI—damage to the pituitary gland due to surgery, a tumor, illness, inflammation, or a head injury Nephrogenic DI—genetic disorder, chronic kidney disorder, certain drugs	Polyuria, polydipsia, urinary frequency, disturbed sleep due to bedwetting, daytime fatigue, fever, headaches, weight loss, low blood pressure
Hypothyroidism	Autoimmune diseases (Hashimoto's disease), surgery to remove all or part of the thyroid, radiation treatment, treatment for hyperthyroidism, certain medications	Unexplained weight gain, dry skin, hair loss, swollen face, hands, legs, ankles, or feet; increased sensitivity to cold, aches and pains in muscles or joints, hoarse or raspy voice, constipation, heavy or irregular menstrual periods, fatigue, slower thinking, trouble remembering things, slower speech, depression, enlarged thyroid, changes in blood cholesterol levels, slow heart rate, infertility
Congenital hypothyroidism	Underdevelopment, absence, failure of the thyroid to migrate to its normal anatomical position, maternal iodine deficiency, maternal ingestion of antithyroid medications during pregnancy	Umbilical hernia and a protruding abdomen, a reduced level of activity and generalized lethargy, continuous weight gain even with poor feeding habits, small stature, physical growth retardation, developmental delay, swelling in the eyelids, enlarged tongue, coarse facial features

Diagnosis	Treatment	Prevention
Blood test confirming high level of GH and imaging tests	Growth hormone replacement therapy	Not preventable except to prevent injury of trauma to the gland
Physical examination, imaging tests, and blood test confirming high GH, biopsy	Surgery, radiation, medications that decrease growth hormone secretion	Not preventable
Medical history, physical examination, blood test confirming high GH, biopsy, imaging tests	Surgery, radiation, medications that decrease growth hormone secretion	Not preventable
Medical history, physical examination, urinalysis, water restriction test	Administer ADH	Not preventable
Medical history, signs and symptoms, blood test confirming low T_4 and T_3 and high TSH, autoantibody testing, imaging tests	Thyroid hormone replacement	Not preventable
Blood test confirming low T_4 and T_3 and high TSH	Thyroid hormone replacement	Not preventable

Disease	Etiology	Signs and Symptoms
Graves' disease	Abnormal immune response	Enlargement of the thyroid, nervousness, irritability, heat intolerance, increased sweating, insomnia, rapid or irregular heartbeat, fatigue, diarrhea, weight loss, ophthalmopathy
Simple goiter	Iodine deficiency, eating a large amount of goiter-producing foods, certain medications, idiopathic	Thyroid gland enlargement, difficulty breathing or swallowing, dizziness, syncope
Thyroid cancer	Not preventable	Does not usually cause signs or symptoms early in the disease, lump in the neck, voice hoarseness, difficulty swallowing, pain in the neck and throat, swollen lymph nodes in the neck
Hyperparathyroidism	Benign parathyroid tumor	Pain in the bones, nervous system is depressed, muscles lose their tone and weaken, pulse slows, gastrointestinal disturbances, abdominal pain, vomiting, constipation, irritation and excessive tearing of the eyes
Hypoparathyroidism	Transient condition that commonly occurs in patients following surgical removal of the thyroid gland	Tetany of the muscles of the hands and feet, lethargy, personality changes, anxiety, blurred vision, trembling of the limbs
Addison's disease	Autoimmune, certain infectious diseases and cancers, hemorrhage of the adrenal gland	Weight loss, fatigue, anorexia hyperpigmentation found in non-sun-exposed areas, loss of appetite, abdominal discomfort, vomiting, diarrhea, hypotension, dizziness, lack of blood sodium, fainting
Cushing's syndrome	Benign pituitary tumor, adrenal tumor, prolonged administration of large doses of cortisone	Fat accumulation behind the shoulders, known as a buffalo hump; a round "moon-shaped" face; fatigue; weakness; impaired wound healing; protruding abdomen; hypertension; weight gain; stretch marks on the skin
Conn's syndrome	Benign tumor of the adrenal cortex	Hypertension, headaches, blurred vision, dizziness, fatigue, numbness, increased urination, increased thirst, muscle cramps, muscle weakness

Diagnosis	Treatment	Prevention
Blood test confirming high T_4 and T_3 and low TSH	Medications, radioactive iodine, surgery	Not preventable
Medical history, physical examination, blood test to measure levels of TH and TSH, imaging tests	Thyroid hormone replacement, small doses of iodine, radiation therapy, surgery	Adequate intake of dietary iodine, monitoring intake of goiter-producing foods and medication
Medical history, physical examination, blood tests to measure levels of TSH and TH, imaging tests, biopsy	Surgery, radioactive iodine treatment, thyroid hormone therapy, radiation therapy, chemotherapy, targeted therapy	Not preventable
Blood test to confirm high PTH and calcium and low phosphorous; urinalysis confirming increased calcium, imaging tests	Surgery, diuretics, limit calcium intake	Not preventable
Physical examination, blood test confirming low PTH and calcium and high phosphate, electrocardiogram, imaging tests	Calcium replacement therapy with vitamin D	Not preventable
Medical history, physical examination, blood tests confirming low cortisol and high ACTH, ACTH stimulation test, imaging tests	Replacement of glucocorticoids and mineralocorticoids	Not preventable
Blood and urine test to confirm high levels of cortisol, imaging tests	Surgery, radiation therapy, medications that block the synthesis of corticosteroids	Not preventable
Blood test to confirm a high level of aldosterone and a low or undetectable level of rennin, imaging tests	Surgery, antihypertensive medication, aldosterone blockers	Not preventable

Disease	Etiology	Signs and Symptoms
Type 1 diabetes mellitus	Immune system attacks and destroys beta cells	Polyuria, polydipsia, polyphagia, weight loss
Type 2 diabetes mellitus	Not preventable, although excess weight and physical inactivity seem to be contributing factors	Polyuria, polydipsia, polyphagia, weight loss, fatigue, blurred vision, numbness or tingling in the hands or feet, slow wound healing
Hypergonadism	Girls—idiopathic; ovarian and adrenal tumors Boys—idiopathic; tumor in the testes or the pituitary gland	Both boys and girls—pubic or underarm hair, rapid growth, acne, adult body odor Girls—breast development, first menstruation Boys—enlarged testicles and penis, facial hair, voice deepening

Diagnosis	Treatment	Prevention
Urine test, blood glucose testing	Insulin, exercising regularly, maintaining a healthy weight, eating a healthy diet, monitoring blood sugar	Not preventable
Urine test, blood glucose testing	Blood sugar monitoring, healthy eating, regular exercise, diabetes medication, insulin therapy	Losing weight, exercising
Review of the child's and family's medical history, physical exam, blood tests to confirm elevated levels of sex hormones	Removal or radiation of tumors, medications to suppress or counteract the sex hormones	Not preventable

Interactive Exercises

Cases for Critical Thinking

1. A mother brings her 5-year-old son to the pediatrician with complaints that her son has been wetting the bed consistently. The child has a good appetite, drinks a lot of water, and has a high metabolism, according to the mother. On examination, the doctor notes that the child has lost 10 pounds since his last physical 6 months ago. What diseases should be ruled out?
2. A 59-year-old woman reports to the doctor's office. The doctor notes the patient's face seems very round, there is a terrible bruise on her leg that was there since her last examination 2 months ago, and the patient has gained weight. What disease might this woman have?
3. A comatose 45-year-old man is brought to the emergency room with severe dehydration, slow deep breathing, and fruity-smelling breath. What disease complication might this man have? What treatment is needed?

Multiple Choice

1. Acromegaly results from hyperactivity of what gland?
 - a. thyroid
 - b. parathyroid
 - c. anterior pituitary
 - d. posterior pituitary
2. Which hormone increases the blood calcium level?
 - a. glucagon
 - b. parathyroid hormone
 - c. androgen
 - d. insulin
3. Hyperglycemia is an indication of which disease?
 - a. Cushing's disease
 - b. Addison's disease
 - c. diabetes insipidus
 - d. Graves' disease
4. Fat accumulation behind the shoulders is an indication of which disease?
 - a. Graves' disease
 - b. Cushing's disease
 - c. Addison's disease
 - d. Conn's disease
5. ADH deficiency causes which disease?
 - a. IDDM
 - b. NIDDM
 - c. diabetes insipidus
 - d. ketoacidosis
6. Which of these disorders is associated with hypersecretion of thyroxine?
 - a. Graves' disease
 - b. gigantism
 - c. cretinism
 - d. acromegaly
7. Which gland secretes epinephrine *and* norepinephrine?
 - a. pancreas
 - b. parathyroid
 - c. testes
 - d. adrenal
8. Which of the following is caused by a deficiency in corticosteroids?
 - a. Addison's disease
 - b. Conn's disease
 - c. diabetes insipidus
 - d. Cushing's syndrome
9. An absolute insulin deficiency is characteristic of _____.
 - a. type 1 diabetes
 - b. gestational diabetes
 - c. type 2 diabetes
 - d. diabetes insipidus
10. Iodine is required for the body to make:
 - a. insulin
 - b. adrenalin
 - c. thyroxine
 - d. glucose

True or False

- | | |
|--|---|
| <p>_____ 1. Kidney stones are likely to form in hypoparathyroidism.</p> <p>_____ 2. Hypercalcemia causes tetany.</p> <p>_____ 3. Glucagon prevents hyperglycemia.</p> <p>_____ 4. Steroids that suppress the inflammatory response, as in arthritis, are produced by the thyroid.</p> <p>_____ 5. Umbilical hernia and a protruding abdomen accompanies Addison's disease.</p> | <p>_____ 6. Insulin is secreted by alpha cells.</p> <p>_____ 7. A person with Graves' disease is very sensitive to cold.</p> <p>_____ 8. Dehydration can develop in diabetes insipidus.</p> <p>_____ 9. Cushing's syndrome results from an excess of glucocorticoids.</p> <p>_____ 10. Glucagon elevates blood glucose level.</p> |
|--|---|

Fill-Ins

- | | |
|--|---|
| <p>1. Overproduction of growth hormone in children results in _____.</p> <p>2. An overproduction of growth hormone in adulthood results in _____.</p> <p>3. The posterior pituitary secretes _____ and _____.</p> <p>4. Microvascular disease is a chronic complication of _____.</p> <p>5. The most common form of hyperthyroidism is _____.</p> <p>6. Insulin is secreted by cells of the pancreas called _____.</p> | <p>7. The _____ glands are located on top of each kidney.</p> <p>8. Tropic hormones are secreted by the _____.</p> <p>9. Pituitary dwarfism is associated with hyposecretion of _____.</p> <p>10. In type _____ diabetes the body resists the effects of insulin or does not produce enough insulin to maintain a normal glucose level.</p> |
|--|---|

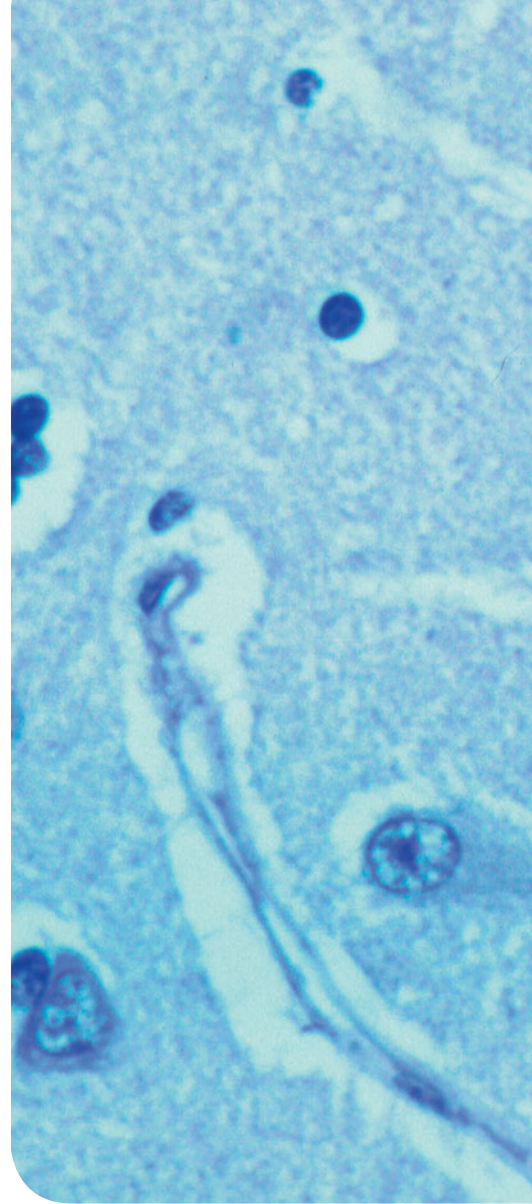
Chapter 13

Diseases and Disorders of the Nervous System

Learning Objectives

After studying this chapter, you should be able to

- Recognize the basic structure and functions of the nervous system and major sensory processes
- Describe the etiology, signs, symptoms, and treatments for traumatic brain injury and traumatic spinal cord injury
- Differentiate the signs and symptoms of the different types of epilepsy, and describe associated etiology, risks, and treatments
- Discuss the etiology, signs and symptoms, diagnostic tests, and treatment of stroke
- Describe the etiology, signs and symptoms, and prognosis of cranial nerve disorders
- Describe the etiology, signs and symptoms, diagnostic tests, and treatment of infectious diseases of the nervous system
- Describe degenerative diseases of the central nervous system, including Alzheimer's disease, multiple sclerosis, Huntington's chorea, Parkinson's disease, and amyotrophic lateral sclerosis
- Understand the etiology, symptoms, treatment, and prognosis of developmental neurological conditions
- Understand the differences between benign and malignant tumors of the brain
- Review age-related diseases of the nervous system



Photomicrograph of a neurofibrillary tangle. (© O.J. Statts/Custom Medical Stock Photo)

Fact or Fiction?

Rusty nails cause tetanus.

Fiction: Tetanus is caused by the toxin of a bacterium *Clostridium tetani*, which inhabits soil contaminated by animal manure. The bacteria thrive in anaerobic conditions. Therefore, a deep, contaminated puncture such as one caused by a nail could introduce the bacteria into a wound and lead to tetanus. The bacteria—not the nail—cause tetanus!



Disease Chronicle

Death to a Killer

Your great-grandparents lived in fear of a paralyzing, tragic infectious disease. Your parents' generation began to break free from the grip of this disease, and today it has nearly been eradicated. What is this devastating disease? Polio.

Polio once thrived in the United States and around the world. In the 1940s and 1950s, it took an especially large toll on the prewar Depression generation and the postwar "baby boom" generation. By 1955, Dr. Jonas Salk and Dr. Albert Sabin had formulated vaccines that finally placed this disease under control. How was that incredible feat accomplished?

Dr. Salk's vaccine consisted of inactivated poliovirus injected intramuscularly, which stimulated production of antibodies against polio virus. With the institution of broad-scale immunization programs, cases of polio dropped immediately. Dr. Sabin developed an extremely effective oral vaccine that was also convenient to administer to large groups. The orally administered Sabin vaccine stimulates the production of antibodies within the digestive system, where the viruses reside. Unlike the Salk vaccine, the Sabin vaccine neutralizes the polio viruses in the digestive system, preventing transmission and eliminating carriers. Even so, researchers believe that the Salk vaccine is the better choice because it employs killed virus, which ensures that the vaccine itself will not transmit live polio viruses. In 2000 the Centers for Disease Control and Prevention recommended using only the Salk vaccine in order to eliminate possible exposure to live viruses.

The World Health Organization projects that polio will be eradicated in the near future. Between 1988 and 1998, polio declined 85% worldwide, and today polio has been eliminated in the United States and from much of the world. The last case of polio in the United States occurred in 1979. In 2003, only 700 cases of polio were found in the world, and three-fourths of these cases were in Nigeria, India, and Pakistan, where underimmunization has enabled polio outbreaks. It remains important to continue immunization, both locally and globally, to end this devastating disease.

Anatomy and Physiology Review

Overview

The nervous system coordinates and controls all of the body's functions and plays a central role in maintaining homeostasis. Organs of the nervous system are organized in two divisions: the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is composed of the brain and spinal cord. The CNS integrates information and controls the peripheral nervous system. The PNS comprises the nerves outside the CNS, including the 12 pairs of cranial nerves and 31 pairs of spinal nerves. These nerves carry information to and from the CNS. Nerves consist of motor nerves, which carry information from the CNS to muscles and glands, and sensory nerves, which carry sensory information from sense receptors to the CNS.

Neurons

The basic unit of the nervous system is the **neuron**, or nerve cell. The neuron consists of a cell body with attached filamentous extensions called *dendrites* that carry information toward the cell body and a filamentous axon that carries information away from the cell body (Figure 13-1 ►). Axons of many neurons are insulated by a lipoprotein covering called **myelin** that forms a sheath, insulating and protecting the neuron. Deterioration of the myelin sheath decreases the impulse velocity and impairs neuron function. Three types of neurons are described. One type is the interneuron, which carries nervous impulses between neurons. The second type is the sensory neuron, which detects environmental stimuli such as touch, light, or pain and transmits messages to the brain or spinal cord. The third type is a motor neuron, which conveys messages from the central nervous system to muscles, causing contraction, or to glands, triggering secretion.

Central Nervous System

The brain and spinal cord comprise the organs of the central nervous system (CNS). Together they integrate and interpret sensory input and direct all activities of the body.

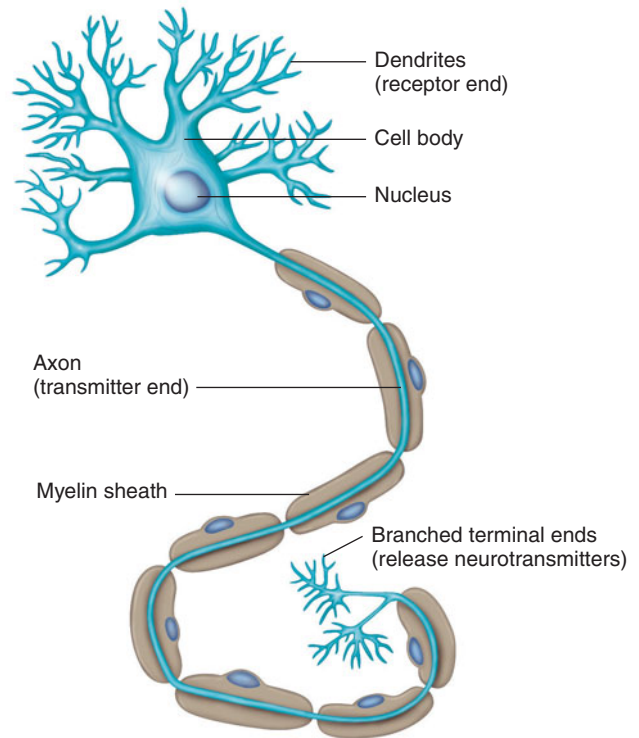


Figure 13-1 ► Typical neuron.

The Brain The brain integrates and stores information, interprets sensory input, and directs all body functions (Figure 13-2 ►). Well protected by bones of the cranium, the brain is also covered by three layers of tissue called the **meninges** that protect the delicate nerve tissue of the brain and spinal cord. The innermost covering is the pia mater, the middle layer is the arachnoid, and the toughest, outermost covering is the dura mater. Between the dura mater and the arachnoid membrane is the subdural space. The subarachnoid space between the arachnoid membrane and the pia mater is filled with cerebrospinal fluid that circulates here, in the brain's ventricles, and in the subarachnoid space around the spinal cord. Cerebrospinal fluid (CSF) is a clear liquid composed of water, protein, glucose, and minerals.

The largest part of the brain is the cerebrum, which interprets sensory information, directs motor activities, and houses intelligence and personality. The cerebrum is divided into two cerebral hemispheres that are connected at midline

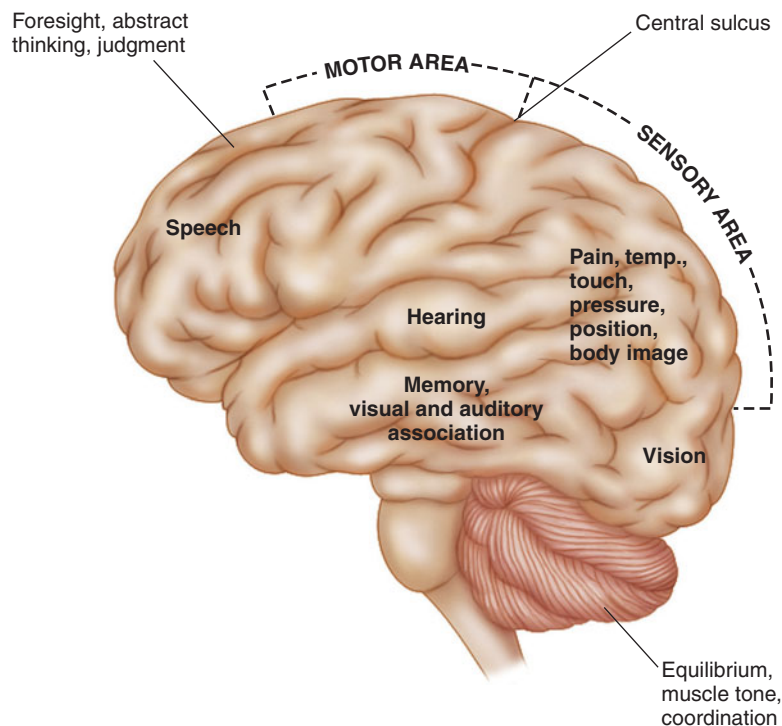


Figure 13–2 ► Specialized areas of the brain.

by nerve fibers of the corpus callosum. In this way the two hemispheres are able to communicate and share information. The outer region of the cerebrum is the cerebral cortex, a distinctively wrinkled region described as gray matter because it consists of neuron cell bodies that appear dull gray. The inner region of the cerebrum consists of axons and is described as white matter because the axons' myelin imparts white color to this area. The inner part of the cerebrum also contains **basal ganglia** that control muscle coordination and steady movement.

The cerebral cortex is further divided by fissures into lobes that possess specialized functions. The frontal lobe controls voluntary muscle actions and the muscles of speech. The frontal lobe also houses regions that govern personality, judgment, memory, and other cognitive functions. The temporal lobes are responsible for senses such as hearing, taste, smell, and the ability to understand spoken language. The parietal lobes interpret the meaning of incoming sensory signals that arrive from the opposite side of the body. The occipital lobe is devoted to

interpreting visual input. The lobes of the two hemispheres receive input from and send information to the opposite side of the body.

The thalamus lies below the cerebrum. The thalamus relays sensory information to the correct areas of the cerebral cortex. Below the thalamus lies the hypothalamus, which controls vital body functions such as temperature, blood pressure, breathing, appetite, and the sleep/wake cycle. The hypothalamus produces some hormones, controls part of the pituitary gland, and serves as intermediary between the nervous and endocrine systems.

The base of the brain includes the cerebellum, pons, and medulla oblongata. The cerebellum lies below the occipital lobe and controls smooth voluntary movements by coordinating sensory input with muscle actions. The cerebellum enables equilibrium and muscle tone. The medulla bridges the brain with the spinal cord. The medulla oblongata helps regulate heart and respiratory rate, and controls smooth muscle of blood vessels. Review Figure 13–2 for illustration of the specialized regions of the brain.

The Spinal Cord The spinal cord carries nerve impulses between the brain and the body. Continuous with the medulla oblongata, the spinal cord extends from the foramen magnum, the opening at the base of the skull, to the first or second lumbar vertebra. Vertebrae, meninges,

and cerebrospinal fluid protect the spinal cord (Figure 13-3 ►). Thirty-one pairs of spinal nerves originate in the spinal cord, carrying bundles of sensory and motor neurons throughout the body. The spinal cord also directs some muscular reflexes in response to sensory input.

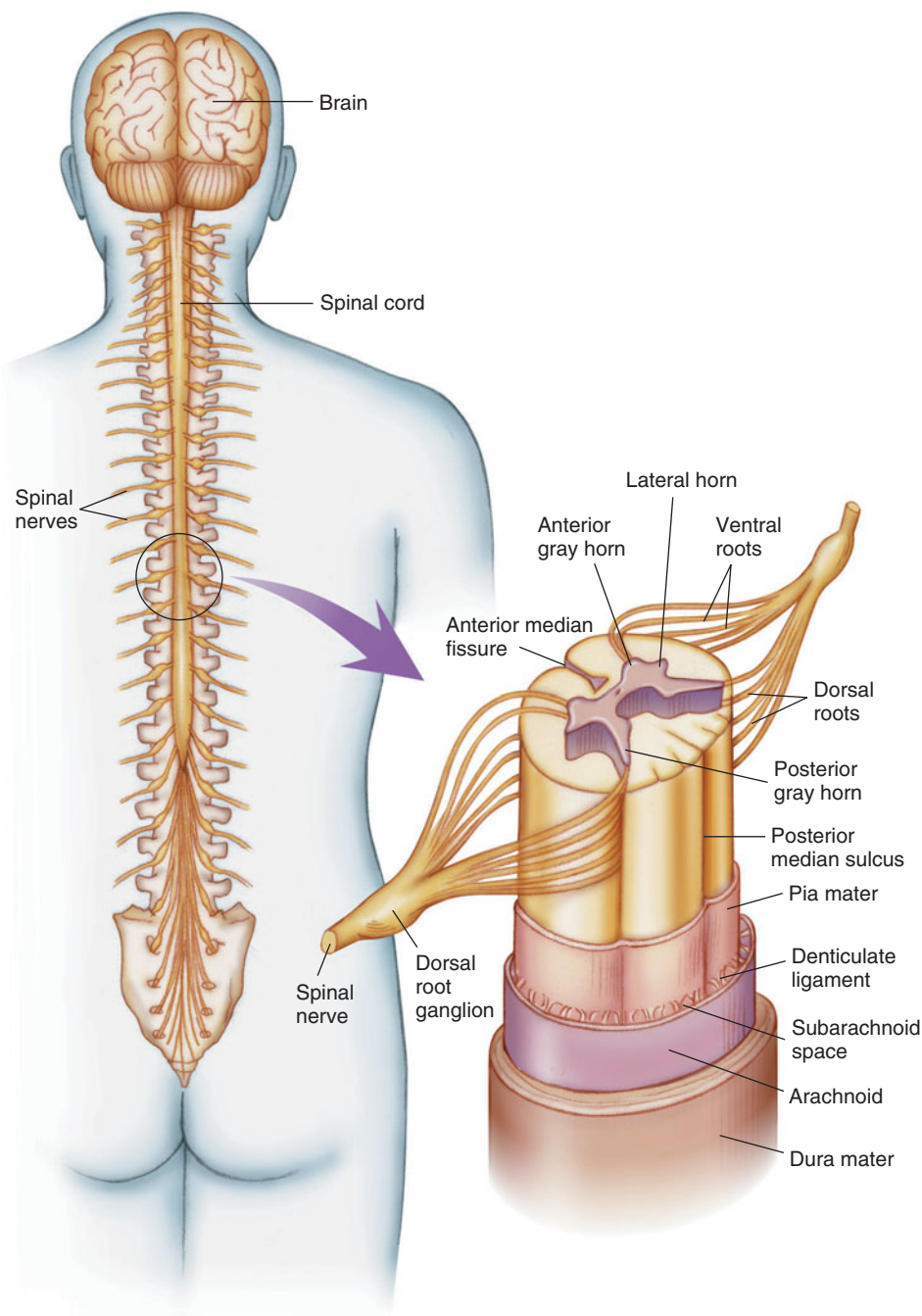


Figure 13-3 ► The brain, spinal cord, and spinal nerves. An expanded view of the spinal cord is shown.

Peripheral Nervous System

The peripheral nervous system (PNS) is composed of nerves, ganglia (bundles of neuron cell bodies outside the CNS), sensory receptors, and sensory organs. The PNS is divided into the somatic system and the autonomic nervous system.

The Somatic System The somatic system controls voluntary muscle actions and receives input from sensory receptors and sensory organs. The somatic system includes 12 pairs of cranial nerves and 12 pairs of spinal nerves. These nerves are composed of sensory neurons, or motor neurons, or both.

The Autonomic Nervous System The autonomic nervous system (ANS) controls glands and involuntary muscle, including cardiac muscle, and smooth muscle in the walls of blood vessels, bronchi, intestines, and other abdominal organs. The ANS is divided into three subdivisions: sympathetic, parasympathetic, and enteric. The sympathetic subdivision is composed of nerves that arise from the thoracic and lumbar areas of the spinal cord. The sympathetic nervous system prepares organs and glands for “fight or flight,” triggering causing bronchial dilation and increased heart rate and blood pressure. The parasympathetic subdivision includes nerves arising from the cranial and sacral regions. These nerves regulate the resting functions of the body. The enteric subdivision is a network of nerves in the abdomen that control the gastrointestinal organs.

Diagnostic Tests and Procedures

Diagnosis of nervous system diseases and disorders includes patient history and may include a neurologic exam to assess cerebral, cerebellar, and nerve function, and mental status, intellect, behavior, and level of consciousness.

Noninvasive diagnostic imaging tests include x-ray, CT, ultrasound, and MRI. **Electroencephalography (EEG)** records the brain’s electrical activity. Invasive laboratory tests include a lumbar puncture (spinal tap) to study CSF (Figure 13-4 ►). In myelography, a radiopaque dye is injected into the subarachnoid space to visualize the spinal cord structure. Angiography allows visualization of the cerebral circulation.

Brain and Spinal Cord Trauma

Trauma to the brain or spinal cord results in mild to severe dysfunction and disability, depending on the extent of the injury. The effects of the injury may be temporary or permanent.

Traumatic Brain Injury

A traumatic brain injury is damage to the brain resulting from external physical forces. In the United States, about 1.7 million people experience a traumatic brain injury each year. Falls are the leading cause of traumatic brain injury, followed by motor vehicle accidents. Other important causes include sports and physical violence. The risk for traumatic brain injury from falls is greatest for those over age 65 and under age 5. Between age 20 and 24, motor vehicle accidents pose the highest risk for traumatic brain injury.

Signs and symptoms depend on the extent of damage to the brain. Concussion is a common type of mild brain injury. Concussion results from a blow to the head or sudden shaking or movement, as may occur in contact sports, falls, and automobile accidents. Physical symptoms may include short-term loss of consciousness, headache, nausea or vomiting, sensitivity to light, and dizziness. Cognitive symptoms may include confusion, inability to concentrate, and memory problems. Concussion is also associated with changes in mood, sadness, irritability, fatigue, and sleep disturbances.

Severe traumatic brain injury occurs in two forms. Closed injuries result from sudden movement of the brain in the skull, such as in falls, automobile crashes, and blows to the head. Open injuries result from penetrating wounds caused by firearms and sharp objects. Signs and symptoms include serious short- and long-term impairments of brain function. Severe brain injuries cause loss of consciousness, amnesia (memory loss), muscle weakness and incoordination, and changes in emotion, personality, and mood. Many changes may be permanent and severe, causing disability and interfering with functions of daily life. About a third of injury-related deaths in the United States involve a severe traumatic brain injury.

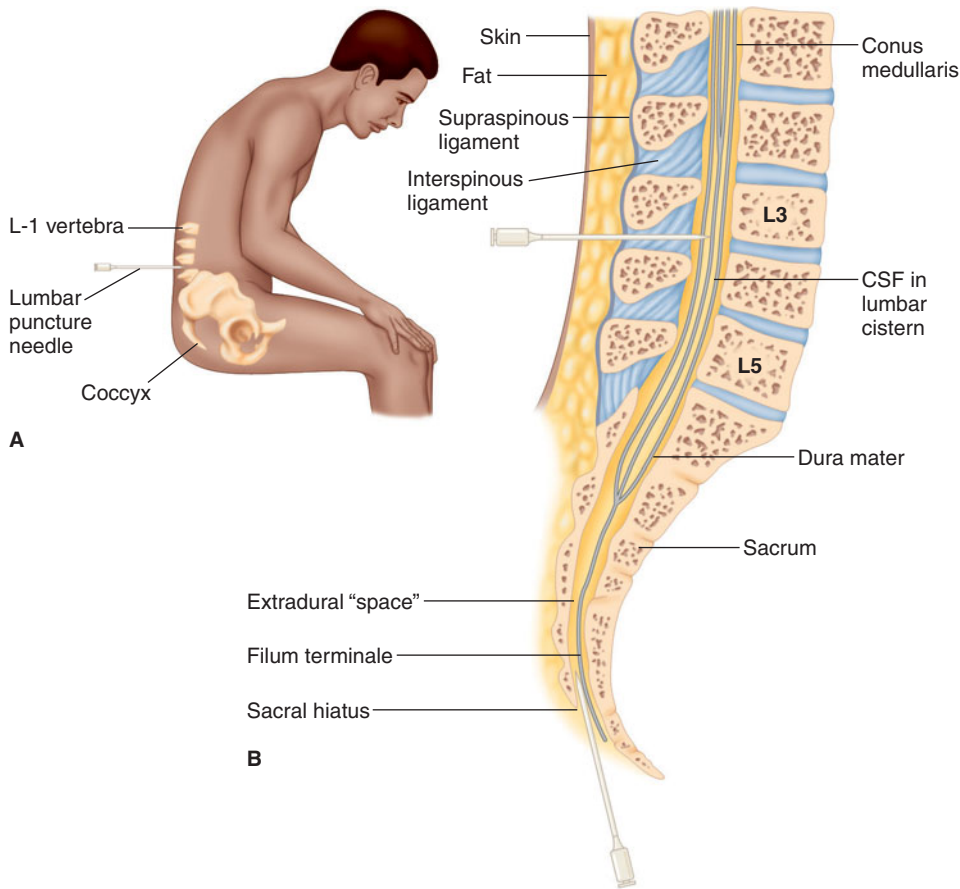


Figure 13-4 ► (A) Lumbar puncture, also known as spinal tap. (B) Section of the vertebral column showing the spinal cord and membranes. A lumbar puncture needle is shown at L3–4 and in the sacral hiatus.

Diagnosis of brain injury requires assessment of brain function, information about the probable cause of the injury, and brain imaging. The Glasgow Coma Scale (GCS; Table 13-1 ►) measures mental function, sensory responsiveness, and motor ability. Higher scores on the GCS mean better brain function. Brain damage can be assessed and located using MRI or CT scans.

Treatment depends on the severity of the injury. Most mild brain injuries and concussions resolve over time with rest. Following a concussion a person should avoid physically and mentally strenuous activities until full recovery. For severe brain injuries there may be no specific treatment. Surgery may be used to remove

foreign objects or broken bone. Drugs can induce a coma to reduce brain metabolism and inflammation. Survivors of severe brain injuries often require intensive physical, occupational, and speech and language therapy. Prevention depends on reducing the risk for falls in the home, wearing seatbelts, and wearing helmets while playing contact sports, bicycling, and motorcycling.

Spinal Cord Injury

Spinal cord injury includes compression, bruising, fractures, or swelling of the spinal cord. Causes include falls, automobile and motorcycle accidents, sports-related injuries, knife

TABLE 13–1 Glasgow Coma Scale

Best eye response	Best verbal response	Best motor response
1 = No eye opening	1 = No verbal response	1 = No motor response
2 = Eye opening to pain	2 = Incomprehensible sounds	2 = Extension to pain
3 = Eye opening to verbal command	3 = Inappropriate words	3 = Flexion to pain
4 = Eyes open spontaneously	4 = Confused	4 = Withdrawal from pain
	5 = Oriented	5 = Localizing pain
		6 = Obeys commands
Score: 15–13, mild; 9–12, moderate; 3–8, severe; less than 3, vegetative		

Prevention PLUS!

Head and Neck Injuries Are Preventable

Brain and spinal cord injuries can be prevented by taking these precautions.

- Always wear a helmet as a driver or passenger on a motorcycle. Always wear a helmet when riding a bicycle, or when using a snowboard or skateboard.
- Never dive into shallow water or water of unknown depth.
- Reduce the chance of falling at home by removing tripping hazards.
- Use ladders according to instructions and work with a partner who can hold the ladder.

Think Critically

1. Some states do not require motorcycle riders to wear helmets. How can you convince riders in these states to wear helmets if the law does not require it?
2. What other recreational or occupational activities require head and neck protection?
3. If there is no cure for spinal injuries, why do some people recover muscle and nerve function following traumatic injuries?

and firearm wounds, and swimming in shallow water. Spinal cord injury also results from severe osteoarthritis, metastatic cancer, or herniated discs.

Symptoms and signs of spinal cord injury vary and depend on the location of the injury. Motor, sensory, and internal organ functions may be partly or completely lost (Table 13–2 ►).

The diagnosis of spinal cord injury requires history and assessment of motor and sensory

functions. CT, x-ray, and MRI determine spinal cord damage. After swelling subsides, motor and sensory functions are tested again.

Treatment aims to reduce the risk for further injury and promote healing. Immediately following injury, the head and neck will be immobilized. Surgery may be needed to remove fluid or bone fragments or to fuse broken discs. Spinal cord damage is essentially irreversible and the extent of recovery depends on the degree of injury.

TABLE 13–2 Symptoms and Signs Associated with Damage to Nerves in Different Areas of the Spinal Column

Spinal cord location	Symptoms and signs
Cervical (neck injury); there are seven cervical vertebrae	Inability to breathe, paralysis of the breathing muscles Loss of bowel or bladder control Numbness Weakness, paralysis Pain Uncontrolled spastic muscle movements
Thoracic (upper middle back) includes 12 thoracic vertebrae	Loss of bowel or bladder control Numbness Changes in sensation Pain Weakness and paralysis Symptoms affect the legs
Lumbar and sacral (lower back) includes five lumbar vertebrae, the sacrum, and coccygeal vertebrae	Loss of bowel or bladder control Numbness Changes in sensation Pain Weakness and paralysis

Epilepsy

Epilepsy is a central nervous system disorder characterized by abnormal electrical activity in the brain. Epilepsy may cause seizures, including loss of consciousness, loss of motor control, and sensory disturbances. Epilepsy is a relatively common disorder in the United States, where it affects more than 2.5 million people. Risk factors include family history of epilepsy, stroke, brain injury, and infections such as meningitis. Age is also a risk factor, with epilepsy usually first occurring in early childhood and after age 60. The cause of epilepsy is related to abnormal brain electrical activity, but is not well understood.

Signs and symptoms vary widely, and epilepsy has been classified by location and characteristics of seizure. For example, epilepsy may be focal, affecting one part of the brain. In contrast, a generalized seizure involves abnormal electrical activity on both sides and in many areas of the brain. Seizure characteristics range from staring spells to the complete loss of motor function and unconsciousness (Table 13–3 ►).

Diagnosis of epilepsy relies on electroencephalography (EEG), a recording of brain electrical activity, and MRI and CT to visualize brain structure. Treatment involves antiseizure medications. While no cure exists, most people can control seizure activity with medicine. Epilepsy cannot be prevented.

Stroke

Stroke is a sudden interruption of blood flow to part of the brain caused by a blood clot or a burst blood vessel within the brain. Lack of oxygen causes brain cells to die within minutes of a stroke’s onset. Each year stroke affects 800,000 and kills 130,000 people in the United States. Because stroke is a vascular disease, stroke and heart disease share many risk factors (Table 13–4 ►). Most strokes are caused by a blood clot, and are classified as ischemic strokes. About 15% of strokes result from a burst blood vessel and are described as hemorrhagic strokes. These may be caused by a brain aneurysm (Figure 13–5 ►).

TABLE 13–3 Epilepsy Classification and Symptoms

Focal seizures	
Simple focal	No loss of consciousness; minor sensory and motor disturbances; tingling and flashing lights, involuntary movements
Dyscognitive focal seizure	Loss of awareness or consciousness; staring and purposeless movements
Generalized seizures	
Absence seizure	Petit mal seizure: staring into space or “daydreaming”
Tonic seizure	Stiffening of muscles
Clonic seizure	Repeated jerking movements of muscles on both sides of the body
Myoclonic seizure	Jerking or twitching the upper body, arms, or legs
Atonic seizure	Loss of normal muscle tone
Tonic-clonic seizure	Grand mal seizure: mixture of all symptoms

TABLE 13–4 Stroke Risk Factors

Controllable risk factors	Uncontrollable risk factors
High blood pressure	Age
Atrial fibrillation	Gender
High cholesterol	Family history
Diabetes	Prior stroke or TIA
Atherosclerosis	Patent foramen ovale
Tobacco use and smoking	
Alcohol use	
Physical inactivity	
Obesity	

Signs and symptoms arise suddenly and include numbness, loss of vision, or muscle weakness on one side of the face or body, confusion, and difficulty walking, speaking, and understanding. Diagnosis involves assessment of cognitive, motor, and sensory function to determine the extent and location of the stroke. CT, MRI, and cerebral angiography can pinpoint

the location of the stroke and determine whether the stroke is ischemic or hemorrhagic, which is important for selecting an appropriate treatment.

Ischemic strokes are treated with clot-busting drugs injected intravenously or directly into the brain's blood vessels near the blood clot using a catheter. Hemorrhagic strokes may be treated with medicines that reduce blood pressure, control intracranial pressure, or counteract blood-thinning medications if the person has been taking these. Surgery may be used to repair blood vessels in the brain. Intense rehabilitation may be needed for physical, speech, cognitive, and emotional complications of a stroke.

A **transient ischemic attack (TIA)** is a “mini-stroke,” a temporary interruption of blood flow to the brain. A TIA causes less severe signs and symptoms but requires immediate medical attention because it may be a precursor to stroke. The underlying risk factors or causes of the TIA should be addressed to reduce the chance for a stroke.

Disorders of the Cranial Nerves

Disorders of the cranial nerves may affect the eyes, hearing, balance, and the muscles of the face or shoulders. Inflammation to the cranial nerves is commonly associated with facial or ocular palsy

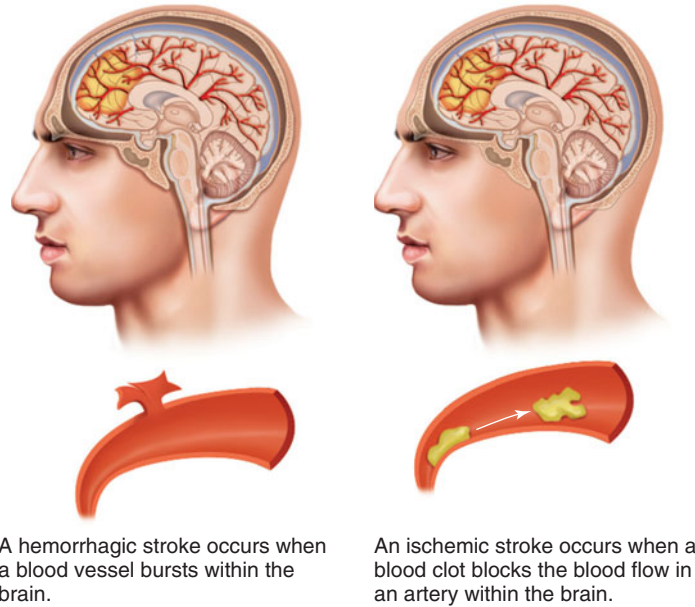


Figure 13-5 ► Hemorrhagic and ischemic stroke.

as well as facial pain. The etiology of cranial nerve inflammation is often unknown but may include viral or bacterial infections or strokes. Two of the most commonly known cranial nerve disorders are trigeminal neuralgia and Bell's palsy.

Trigeminal Neuralgia

Trigeminal neuralgia is severe chronic pain resulting from dysfunction of the fifth cranial nerve, known as the trigeminal nerve, which transmits sensory information from the face and jaw. Trigeminal neuralgia, also called *tic douloureux*, is a rare disease that usually occurs after age 50, although it also may affect younger adults and children. Symptoms include sudden, stabbing pain resembling electric shock in the lips, gums, or chin. The pain can be triggered by touching the face, chewing, drinking, or talking. Trigeminal neuralgia has been described as the most painful medical condition ever reported.

The cause of trigeminal neuralgia remains unknown, although it may be related to demyelination of trigeminal neurons. Diagnosis requires a physical exam and history. Trigeminal neuralgia is treated with antiseizure medicine,

antidepressants, and analgesics. It cannot be prevented.

Bell's Palsy

Bell's palsy is a paralysis of facial muscles caused by inflammation of the facial nerve. The prevalence of Bell's palsy is unknown, but risk factors include recent respiratory infections and pregnancy. The nerve inflammation that causes Bell's palsy is probably triggered by a viral infection or immune disorder. Signs and symptoms appear suddenly, occur on one side of the face, and include the inability to salivate, form tears, blink, and move facial muscles, which results in a drooping eyelid, lips, and an expressionless face (Figure 13-6 ►). Diagnosis requires physical exam of the face and a history to rule out stroke, Lyme disease, and tumors. If necessary, an MRI or CT can be used to confirm the diagnosis and to view possible structural causes of inflammation. Treatment of Bell's palsy includes anti-inflammatory medication and antiviral medications if the paralysis is related to a viral infection. Most people recover within a few weeks. Bell's palsy cannot be prevented.



Figure 13–6 ► Bell's palsy, showing typical drooping of one side of the face.

Infectious Diseases of the Nervous System

Meningitis

Meningitis is an acute inflammation of the first two meninges that cover the brain and spinal cord: the pia mater and the arachnoid mater. Meningitis is often infectious and contagious and usually affects children and young adults. The most common types of meningitis are acute bacterial meningitis and viral meningitis. In recent years bacterial meningitis has caused more than 4,000 cases and about 500 deaths annually in the United States.

Bacterial Meningitis Bacterial meningitis is a severe infection that requires immediate medical attention to prevent serious complications or death. The most common bacterial cause is *Streptococcus pneumoniae* (the pneumococcus). Other bacterial causes include Group B streptococci, *Neisseria meningitides* (the meningococcus), *Listeria monocytogenes*, and *Haemophilus influenzae* type b (Hib). Infant vaccination has

greatly reduced the occurrence of meningitis caused by Hib.

In most cases, the bacteria are spread in respiratory droplets and secretion, usually during close contact as when kissing. Unlike the other meningitis bacteria, *Listeria monocytogenes* can be acquired in contaminated food. Bacteria usually infect the meninges after entering the blood.

Signs and symptoms of bacterial meningitis include a severe headache and stiff neck, high fever, chills, vomiting, confusion, and sensitivity to light. Signs and symptoms in infants may include a bulging fontanel, irritability, and poor reflexes. Meningococcal meningitis also causes a skin rash. All cases require emergency medical attention.

Diagnosis requires physical exam and history and analysis of cerebrospinal fluid obtained by lumbar puncture (spinal tap) for bacteria (review Figure 13–4). In bacterial meningitis, CSF has low glucose and elevated leukocytes and protein. Analysis of CSF and blood may reveal the bacterial cause. CT or MRI may be used to visualize location and extent of swelling.

Bacterial meningitis is treated with intravenous antibiotics. Corticosteroids are used to control swelling. Immediate treatment significantly reduces the risk for death and disability. Even with treatment, complications include hearing loss, cranial nerve damage, mental disabilities, or paralysis. The Hib, pneumococcal, and meningococcal forms of meningitis can be prevented with vaccines.

Viral Meningitis Viral meningitis occurs more commonly than bacterial meningitis. Enteroviruses cause most cases of viral meningitis. Other viral causes include herpes simplex virus, HIV, West Nile virus, and mumps. Most cases of viral meningitis are mild and resolve on their own. No specific treatment is available. Symptoms can be treated with rest, analgesics, and anti-inflammatories. Other rare causes of meningitis include fungi and cancer.

Encephalitis

Encephalitis is an inflammation of the brain, most often caused by a viral infection. Severe encephalitis is rare in the United States. Most cases are mild, but if it becomes severe, encephalitis

is very dangerous and brings serious complications and high mortality. Viral causes include arboviruses, which are transmitted by mosquitoes, enteroviruses, and the viruses that cause herpes simplex, chickenpox, and shingles. West Nile virus causes a type of encephalitis transmitted by mosquitoes (Figure 13-7 ►).

Symptoms of encephalitis include headache, fever, muscle and joint aches, and weakness. Rarely, severe cases occur and include symptoms such as severe headache, confusion, perceptual changes, weakness, and seizures. However, most cases of encephalitis are mild and require no specific treatment.

Diagnosis of encephalitis is made by lumbar puncture for analysis of CSF. Blood may be drawn for analysis. CT or MRI may be used to visualize brain swelling. No specific treatment is available. Symptoms can be treated with rest, analgesics, and anti-inflammatories. Encephalitis cannot be prevented, except by avoiding mosquitoes. The prognosis is good for most cases.

Poliomyelitis

Poliomyelitis (polio) is a crippling, potentially fatal viral infection. Nearly eradicated worldwide by vaccination, the last case of polio in the United States occurred in 1979 (Figure 13-8 ►). Polio occurs sporadically in Nigeria, Pakistan, India, and Afghanistan where immunization programs remain incomplete. Thus, risk factors for polio include lack of vaccination and travel to areas with endemic polio.



Figure 13-7 ► *Aedes* mosquito, the vector for West Nile virus encephalitis. (Centers for Disease Control and Prevention/Robert S. Craig)



Figure 13-8 ► Polio eradication campaign in Georgia in the 1950s. In the 1950s, 20,000 cases of polio occurred annually. After vaccination began, the number of cases plummeted to 10 in 1979. (Centers for Disease Control and Prevention)

The polio virus is transmitted orally and infects motor neurons. Therefore, muscles weaken, atrophy, and may become paralyzed. Death follows respiratory and cardiac failure.

Most cases of polio are not paralytic. Signs and symptoms of nonparalytic polio include fever, sore throat, headache, weakness, vomiting, stiff neck, and backache. The recurrence of symptoms many years after initial infection is known as postpolio syndrome (PPS). Fortunately, vaccination prevents polio, and it no longer occurs in the United States.

Rabies

Rabies is viral infection of the brain in wild mammals, mainly bats, raccoons, coyotes, foxes, and skunks. It can also infect unvaccinated domestic dogs and cats. Rabies can be transmitted to humans through the bite, scratch, saliva, or urine of an infected animal. Animal and human vaccination has made rabies rare in the United States. It affects about one person each year. The risk for rabies is highest among people who work with animals, such as veterinarians, animal control officers, and wildlife biologists.

Following entry into human tissue, typically through a bite or scratch, the virus moves to the spinal cord and brain. The incubation period for rabies may be one month to a year, and depends on the location of the wound. The mode of rabies transmission to the central nervous system is illustrated in Figure 13-9 ►.

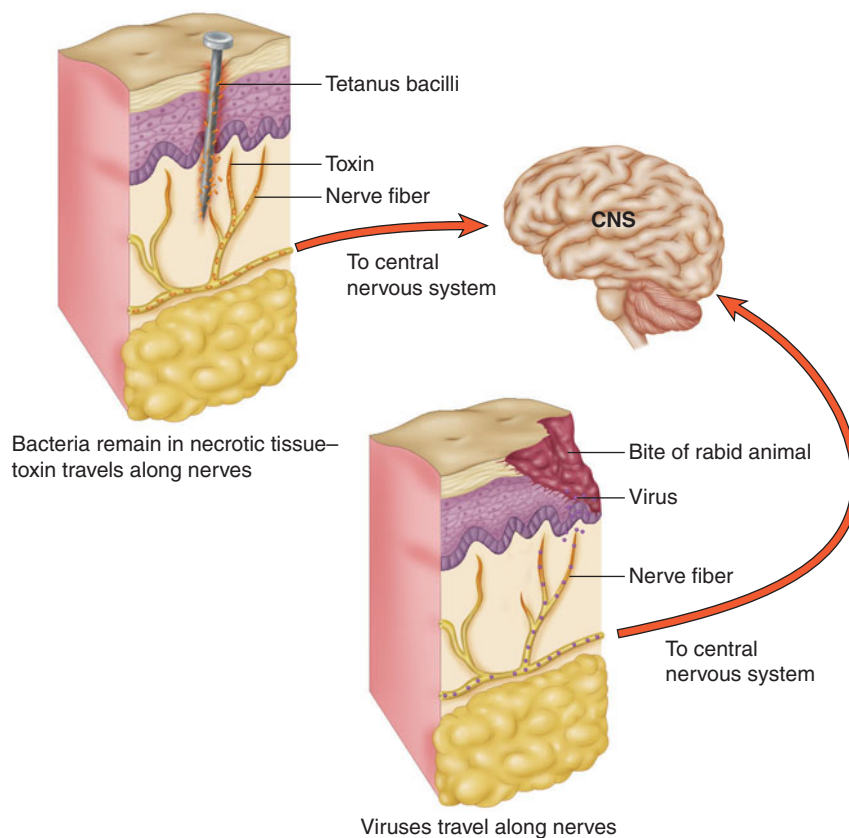


Figure 13–9 ► Nerve involvement in tetanus and rabies.

Signs and symptoms of rabies occur late in the course of the disease, usually only days before death. These include fever, headache, agitation, confusion, hallucinations, difficulty swallowing and excess salivation, fear of water (hydrophobia), insomnia, and partial paralysis. Once symptoms occur, rabies is nearly always fatal.

Treatment should begin if exposure is suspected. Treatment requires immunoglobulin injections near the wound. These injections are given to neutralize the virus before it can move into the nervous system. In addition, a series of five vaccinations are given in the arm to stimulate the body's immune system to fight the virus.

Rabies can be prevented by vaccinating domestic dogs and cats. People at risk for exposure should receive the rabies vaccine.

chickenpox virus, the varicella zoster virus. Each year, shingles affects nearly 1 million people in the United States. Shingles occurs mainly in those over age 50 and in those who are immune-compromised. The risk for shingles is associated with a prior chickenpox infection and with age.

Signs and symptoms of shingles include a band of painful, red, watery blisters around the trunk, often on one side. These may occur on the face, around the eyes, or on other areas (Figure 13–10 ►). In some cases, pain continues after the rash clears, a condition called *postherpetic neuralgia*.

No specific treatment is available for shingles. Treatment may include antiviral agents, ice, lotions, and anti-inflammatories. Shingles can be prevented with the chickenpox vaccine in children or the shingles vaccine in adults.

Shingles (*Herpes zoster*)

Shingles is an acute painful inflammation of sensory neurons caused by reactivation of the latent

Tetanus

Tetanus is a condition of acute muscle rigidity and paralysis caused by a bacterial nerve toxin.



Figure 13-10 ► Shingles rash on the trunk. (Centers for Disease Control and Prevention/Joe Miller)

Tetanus is rare in the United States, affecting about 30 people annually in recent years. In contrast, 1 million cases occur each year throughout the world, mainly in underdeveloped nations where vaccination is unavailable. Those at highest risk for fatal tetanus are not vaccinated.

Tetanus is caused by the tetanus toxin, a nerve toxin produced by the bacterium *Clostridium tetani*. The tetanus toxin binds motor neurons, stimulates them, and causes muscles to be continually stimulated to contract. For that reason, tetanus is commonly called “lockjaw.” This also explains the signs and symptoms of tetanus, its characteristic muscle rigidity, painful muscle spasms (Figure 13-11 ►), difficulty swallowing, and respiratory failure. The rigid, flexed jaw is called **trismus**.

The tetanus bacteria live in animal and human intestines. Because the tetanus bacteria are excreted in animal feces and can persist in the soil, the bacteria are often found in manure or in soils fertilized with manure. A deep, penetrating wound containing contaminated soil can introduce the bacteria into the tissues. Because tetanus bacteria are anaerobic (not requiring oxygen), they thrive in deep wounds that lack oxygen.

Tetanus is diagnosed using a patient’s history. Tetanus cannot be cured. Treatment requires cleaning and disinfection of a wound. If the person is unimmunized, immunoglobulin injections are necessary to neutralize the toxin. If the person’s last tetanus vaccination occurred more than 10 years ago, immunization with inactivated toxin is necessary to boost the immune response to the toxin.



Figure 13-11 ► Patient showing opisthotonos, generalized contraction of muscles due to tetanus toxin. (Centers for Disease Control and Prevention)

Botulism

Botulism is a condition of muscle weakness and paralysis caused by a bacterial nerve toxin. Botulism is rare in the United States, affecting about 145 people annually in recent years. Botulism occurs in three forms. Infant botulism is most common, followed by foodborne and wound botulism. Risk factors for infants include eating honey. Other risk factors for botulism include consuming home-canned foods and injection drug use, especially heroin.

Botulism is caused by the botulinum toxin, a nerve toxin produced by the bacterium *Clostridium botulinum* that binds motor neurons and prevents them from sending signals to muscles for contraction. As a result, muscles become weak and paralyzed and are unable to contract, a condition called *flaccid paralysis*.

Signs and symptoms in infants usually begin with constipation. Affected infants are described as “floppy babies” because they are unable to hold up their heads and move their muscles. Infants may have difficulty crying and swallowing. They may drool and have difficulty sucking and feeding. Foodborne botulism is characterized by droopy facial and eye muscles, difficulty swallowing or speaking, nausea, double vision, vomiting and cramps, and difficulty breathing. Wound botulism resembles foodborne botulism.

The botulism bacteria thrive in anaerobic conditions. They are found in soil and can contaminate food and wounds. Infants may ingest the bacteria or their spores in soil or honey. Foodborne

botulism is usually transmitted by eating improperly canned low-acid foods such as green beans, beets, or corn. Garlic-infused oil has been linked to botulism. Wound botulism follows a deep, contaminated wound that permits the bacteria to grow in anaerobic conditions. In the United States, most cases of wound botulism occur in heroin users who inject heroin daily.

Botulism is diagnosed with physical examination and patient history. Infant botulism can be treated with botulism immunoglobulin to neutralize the toxin. Foodborne botulism can be treated with medications that promote vomiting and bowel movements to clear out the bacteria and its spores. Botulism is also treated with injected antitoxin. In all cases, respiratory assistance may be needed. Early treatment provides the best chances for recovery. Restoration of nerve and muscle function may be slow and requires physical therapy. Infant botulism can be prevented by never feeding honey to infants. Proper canning of food (249.8°F [121°C] for 30 minutes) can prevent foodborne botulism. Wound botulism can be prevented by never using injection drugs such as heroin.

Reye Syndrome

Reye syndrome (RS) is an uncommon but potentially disabling or fatal neurological illness that occurs in children after a viral infection. Infants and children who use aspirin during flu and chickenpox infections are at risk for RS. Fortunately, the link between aspirin and RS has become widely known and, as a result, the incidence of RS has declined significantly.

Liver and brain inflammation occur in RS. Signs and symptoms include persistent vomiting, a rash, and lethargy about 1 week after a viral infection. Serious cases lead to seizures and coma.

The diagnosis of RS requires a patient history. A liver biopsy provides a definitive diagnosis, showing fatty changes in the microvasculature in liver tissue. Blood tests may reveal elevated fatty acids.

Treatment is nonspecific. Treatment aims to lower intracranial pressure. Many children recover, but with neurologic complications such as intellectual disability, seizure disorder, cranial nerve damage, and motor nerve damage.

Degenerative Diseases of the Nervous System

Degenerative diseases produce progressive loss of function in organs of the nervous system. Therefore, these diseases cause various problems with motor, sensory, cognitive, and emotional processes. These diseases are chronic and incurable.

Alzheimer's Disease

Alzheimer's disease (AD) is the most common form of dementia. AD results in progressive destruction of memory and nearly all other important brain functions. The risk for developing AD is linked to age. About half of those over age 85 have AD. The risk for AD is elevated for those with a parent or sibling with AD.

The cause of AD is unknown. Only 5% of cases are linked to known genes and considered hereditary. Observations of AD brain tissue have revealed certain abnormalities. In AD the connections between neurons die, as do neurons themselves (Figure 13–12 ►). In addition, AD brains have dense knots of protein deposits called *plaques*. Tangles of protein called *neurofibrillary tangles* develop within neurons. These plaques and tangles may be related to the development of AD pathology.

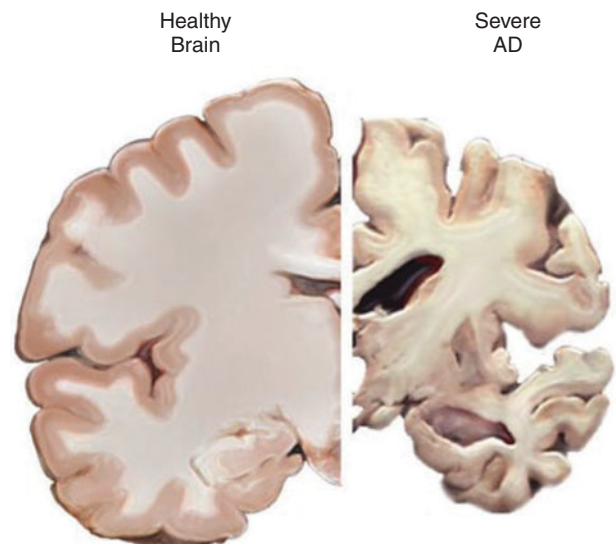


Figure 13–12 ► Alzheimer's disease causes death of many neurons. This is manifested both microscopically and macroscopically at autopsy.

Healthy Aging

Exercise Maintains the Brain

Don't forget the mental and cognitive benefits of exercise. Seniors who are active enjoy sharper cognitive skills and better mental and emotional health. Exercise may also reduce the risk for dementia and Alzheimer's disease. Start your exercise program now so that it becomes a lifelong habit as you age. Your brain will thank you for it.

Signs and symptoms of AD often begin with memory loss and confusion. The inherited forms may have an early onset, in the 40s or 50s. Most other forms begin later in life. Over time, people lose memory, spatial and temporal orientation, become more confused, and exhibit swings in emotion and personality changes. The disease eventually leaves people unable to care for themselves. Death results from pneumonia, other infections, or injuries from falls and accidents.

AD must be diagnosed by exam and history. Neurological exam, blood tests, CT, and MRI are used to rule out other possible causes. Only autopsy can confirm AD. No cure exists and the existing treatments do not restore function or delay the disease.

Multiple Sclerosis

Multiple sclerosis (MS) is a chronic, progressive, degenerative disorder of the central nervous system. MS affects 400,000 people in the United States, with an estimated 10,000 new cases occurring annually. The risk for MS is associated with age, almost always occurring between age 15 and 50, and usually between 20 and 40. Women are at greater risk than men.

MS is an autoimmune disorder characterized by nerve inflammation and myelin destruction (Figure 13–13 ►). Signs and symptoms include numbness, weakness, fatigue, double vision, or vision loss. Several types of MS have been identified. Most forms include periods of remission and exacerbation. The disease progresses at different and unpredictable rates, leading to more severe signs and symptoms. Loss of motor function, bladder and bowel control, and cognitive decline occur as the disease progresses.

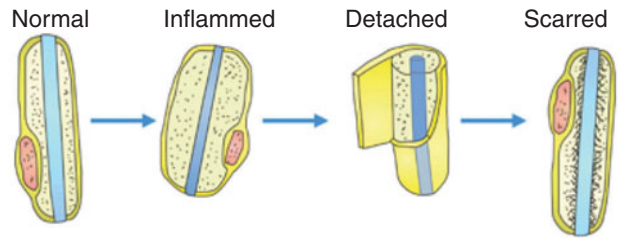


Figure 13–13 ► Multiple sclerosis is characterized by damage to the myelin sheath surrounding the axons of motor neurons. As the myelin becomes damaged and scarred, the axons no longer transmit impulses efficiently.

Diagnosis requires history and neurological exam to rule out other diseases. MRI is used to visualize nerve tissue damage that occurs in MS. Treatment includes physical therapy and occupational therapy. Medical treatment includes antispasmodics to control muscle spasms, corticosteroids to control inflammation, antiseizure medications that suppress tingling and numbness, and immune system modulators to suppress immune-mediated exacerbations.

Unfortunately, MS cannot be prevented, although exacerbations, progression, and symptoms can be controlled.

Amyotrophic Lateral Sclerosis

Amyotrophic lateral sclerosis (ALS), also known as *Lou Gehrig's disease*, is a serious terminal disease characterized by progressive loss of motor function. ALS affects about 30,000 people in the United States. Risk for ALS is associated with age, with increasing risk after age 30. Risk is also associated with gender, affecting more men than women.

The cause of ALS is unknown. ALS is characterized by destruction of motor areas and nerves, which leads to its hallmark signs and symptoms. These usually begin with twitching and weakness in the limbs and slurred speech. With disease progression come paralysis and the inability to chew, swallow, speak, and breathe. While the disease progresses differently in people, death from pulmonary failure or lung infections occurs 3–5 years after the onset of symptoms.

Diagnosis begins with history of signs and symptoms. An electromyogram permits study of muscle activity. A nerve conduction study measures motor nerve function and MRI is used to visualize nervous system changes and damage associated with ALS.

Treatment cannot cure ALS. One medication can slow the progression of ALS, probably by lowering the level of the neurotransmitter glutamate. Other medications can treat the various symptoms. Physical, occupational, and speech therapy help people adjust to the physical impairments. ALS cannot be prevented.

Parkinson's Disease

Parkinson's disease (PD) is a degenerative disease characterized by progressive loss of control over muscle coordination and movement. PD affects about half a million people in the United States, but experts feel PD may be more prevalent because many cases remain undiagnosed.

Risk factors for PD include age and sex. The average age of onset is 60 and the risk increases with age. Early-onset PD, occurring before age 50, accounts for about 5% of PD cases. Men are at higher risk than women.

The cause of PD is related to reduced levels of the neurotransmitters dopamine and norepinephrine. Loss of dopamine is caused by the death of dopamine-producing neurons in the brain region called the *substantia nigra*. Without dopamine,

the substantia nigra cannot communicate with motor regions that produce smooth, coordinated muscle movements. Loss of norepinephrine is due to death of neuron endings responsible for its production. Because norepinephrine controls sympathetic functions, its reduction affects heart rate and blood pressure. The result in PD is fatigue; irregular heartbeat; low blood pressure; and associated dizziness, especially upon standing. What causes the death of these key neurons remains unknown. Scientists have been investigating environmental toxins, viruses, and genes.

Signs and symptoms often begin with noticeable shaking in the hand and rigid, masklike facial muscles. Over time, these progress to tremors; stiffness; the inability to initiate movement; uncoordinated, shuffling gait; and loss of reflexes. Other signs and symptoms include problems swallowing and chewing, difficulty speaking, hunched posture, cognitive impairments, and sexual dysfunction. Depression affects many people with PD. Figure 13–14 ► summarizes possible effects of PD.

Diagnosis of PD requires physical exam, neurologic exam, and history. No blood tests can detect PD. Imaging tests do not usually help diagnosis because MRI or CT appear normal in PD.

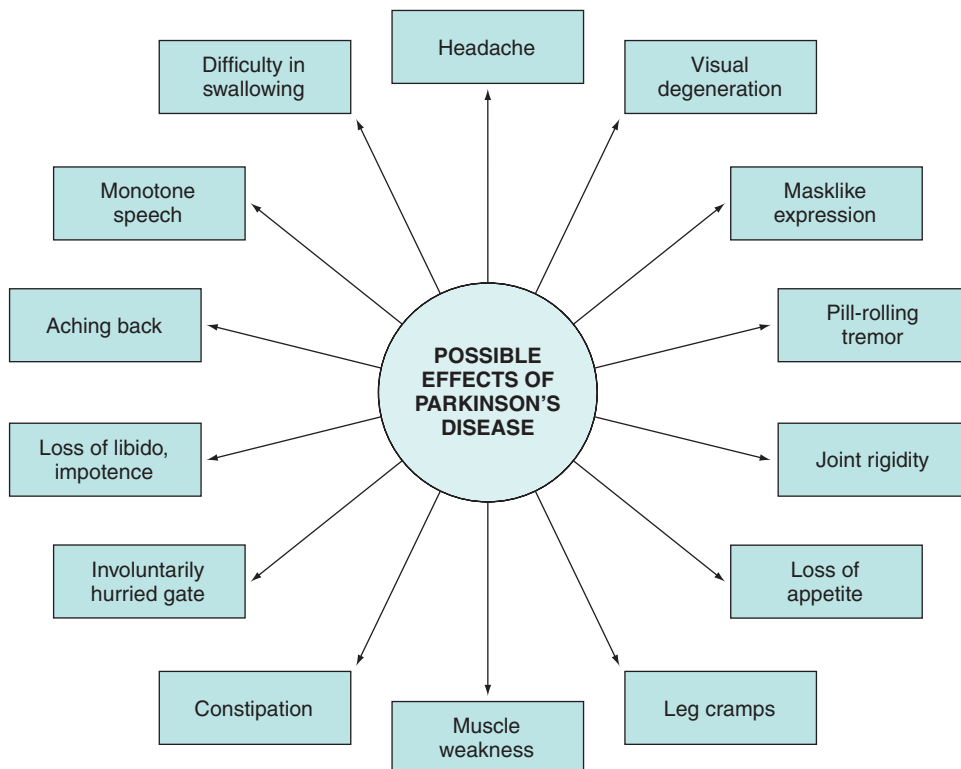


Figure 13–14 ► Summary of Parkinson's disease effects.

Treatment should begin as early as possible. The main medical treatment for PD is levodopa (L-dopa). Dopamine itself cannot move across the blood-brain barrier, but L-dopa can. Once inside the brain, L-dopa is converted into dopamine. L-dopa levels can be prolonged by administration of carbidopa. L-dopa does not cure PD, but it can significantly reduce motor problems such as stiffness and uncoordination. Over time, L-dopa medication must be adjusted as the body adapts to the medicine and as PD progresses. Deep brain stimulation, which sends electrical signals via electrodes into the substantia nigra, might be used for severe symptoms of advanced PD. Counseling and medication are important for treating depression, a common problem for people with PD. Unfortunately, because the causes remain unknown, PD cannot be prevented.

Essential Tremor

Essential tremor is a disorder characterized by shaking of hands and head, especially during voluntary movements. In the United States more than 5 million people have essential tremor, although many are probably undiagnosed. The risk for essential tremor is related to age and genetics. After age 40 the prevalence of essential tremor increases greatly. About half of cases are caused by autosomal recessive gene.

Signs and symptoms include shaking hands and head in a “yes” or “no” pattern. Essential tremor makes it difficult to eat, drink from a glass, write, and grasp objects. Voice tremors also occur. Early signs and symptoms may be confused with Parkinson’s disease, but the two do not share signs, symptoms, or underlying causes.

Diagnosis requires a history and physical exam. The ability to perform simple movements and draw are used to diagnose essential tremor. Blood tests and imaging tests may be used to rule out other diseases.

Treatment involves beta blockers, antiseizure medications, and tranquilizers. Botox injections can improve head and voice tremors. Physical and occupational therapy can teach adaptive skills and improve strength and coordination. Deep brain stimulation may be used for severe tremors that do not respond to medication. Essential tremor cannot be prevented.

Huntington’s Disease (Huntington’s Chorea)

Huntington’s chorea is a progressive degenerative disease of the brain that affects motor and cognitive function. *Chorea* refers to involuntary and ceaseless, rapid, jerky movements. Huntington’s disease (HD) affects about 30,000 people in the United States. The chief risk factor is having a parent with HD. Because it is an autosomal dominant disorder, having a parent with HD gives each child a 50% chance of inheriting it. HD is caused by a defective gene on chromosome 4 that results in the death of specific neurons in the brain.

Signs and symptoms usually begin in the 40s. Motor functions degenerate, and HD is characterized by jerking, writhing movements; involuntary sustained muscle contractions; and difficulty walking, speaking, swallowing, and moving the eyes. Cognitive and mental degeneration includes difficulty planning, loss of visual perception, inflexible thinking, and impaired memory. HD also causes loss of judgment and impulse control. Angry outbursts and personality changes accompany the progressing disease. People cannot work or live independently. Those with HD have a high risk for depression and suicide. Death follows about 10–30 years after onset of symptoms.

Diagnosis requires history, patient interview, neurological exam, and psychiatric exam. Imaging techniques such as MRI may appear normal early in the disease. An EEG can reveal changes characteristic of HD and a genetic test can confirm the presence of the defective gene.

Treatment is aimed at restoring muscle flexibility and movement and treating depression and related psychiatric and psychological conditions. There is no cure for Huntington’s chorea. HD cannot be prevented. However, genetic testing is available to identify carriers of the defective gene.

Developmental and Congenital Disorders

Spina Bifida

Spina bifida is a type of neural tube defect, a developmental structural abnormality in the formation of the vertebrae and spinal cord. In spina bifida the vertebrae fail to fuse correctly, producing a weak spot over the spinal cord or

an opening that exposes the spinal cord. Spina bifida is the most common neural tube defect in the United States. It occurs in about 1,500 of the 4 million babies born each year in the United States. The risk factors include having a previous child with spina bifida. Folate deficiency (vitamin B₉) is also linked to the risk for spina bifida. Other conditions that raise the risk include maternal obesity and diabetes. However, the cause of spina bifida remains unknown. The spinal column and vertebrae form normally by the 28th week of pregnancy, so risk factors should be addressed before pregnancy.

The signs, symptoms, and effects of spina bifida vary and depend on the extent of the neural tube defect. The various forms of spina bifida are shown in Figure 13–15 ► and include spina bifida occulta, meningocele, meningocele, and myelocele. Occulta often goes unrecognized and is characterized by a dimple or tuft of hair near the defect. Meningocele is rare and is characterized by protrusion of the meninges through a small opening. This can be repaired surgically. Occulta and meningocele do not cause neurological problems. A meningocele and myelocele are the most common and more serious defects in which an opening exposes the spinal cord.

Signs and symptoms include motor weakness, paralysis, and loss of bowel and bladder control.

Spina bifida can be diagnosed upon examination. Diagnosis in the fetus can be done by measuring maternal levels of alpha-feto protein, which may indicate the presence of spina bifida in the fetus. Ultrasound and amniocentesis can also be used to visualize the defect in the fetus.

Treatment involves surgery for meningocele, meningocele, and myelocele. Prenatal surgery may also be done. Physical therapy, occupational therapy, and counseling help children adapt and develop classroom, mobility, and bathroom skills. Folic acid supplementation before and during pregnancy may help prevent spina bifida.

Hydrocephalus

Hydrocephalus is a condition of the buildup of CSF around the brain. Hydrocephalus is among the most common birth defects, affecting about 1 in 500 births in the United States. Around 70–90% of children with spina bifida also have hydrocephalus. Risk factors include having spina bifida, brain trauma, and infections such as meningitis, mumps, and rubella or syphilis

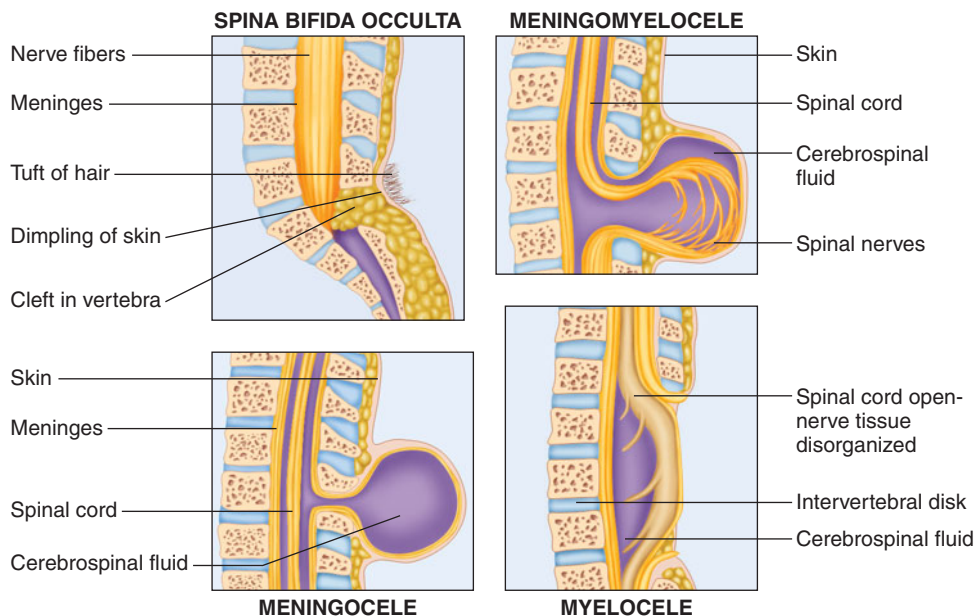


Figure 13–15 ► Forms of spina bifida.

Promote Your Health

Prevent Nervous System Birth Defects

The prevalence of spina bifida has decreased significantly since the introduction of folate (vitamin B₉) supplementation. Women who are considering becoming pregnant should begin taking folate and not wait until they know they are

pregnant. The spinal cord defects of spina bifida originate very early in pregnancy, even before a woman may know she is pregnant.

during pregnancy. The cause is an accumulation of CSF in the brain's ventricles due to an imbalance between CSF production and drainage. The accumulation can be triggered by congenital defects in the structure of the brain's ventricles and vessels, inflammation, infection, or trauma.

Signs and symptoms in infants include bulging fontanel, large head, downward-facing eyes (sun-setting), vomiting, seizures, poor feeding, and uncoordinated movements. Hydrocephalus can lead to permanent motor and cognitive impairments.

Diagnosis requires a physical exam and imaging with MRI or CT. Treatment includes an implanted shunt to help move and drain CSF fluid (Figure 13–16 ►). The fluid may be drained to the jugular vein or peritoneal cavity. A shunt will probably be used for life. Hydrocephalus cannot be prevented.

Cerebral Palsy

Cerebral palsy (CP) is a congenital disorder characterized by impaired muscle movement, tone, and posture. CP is almost always present at birth and affects about 1 in 300 children. Cerebral palsy is usually apparent before 3 years of age. Risk factors include preterm birth, breech birth, and low birth weight. Infant illnesses such as meningitis, encephalitis, and jaundice raise the risk for CP. Other risk factors include maternal infections such as rubella, chickenpox, cytomegalovirus, toxoplasmosis syphilis, and maternal exposure to toxins such as methyl mercury. The cause remains unknown. CP is probably triggered by infection, inflammation, and/or low oxygen supply to the brain.

Signs and symptoms vary and depend on the type of CP and extent of brain damage. The disorder does not progress over time. Muscle problems

include abnormal rigidity or floppiness of muscles. Muscle movement is jerky, stiff, and writhing. People with CP have trouble walking, grasping objects, and producing smooth, fine movements. Excessive drooling and difficulty swallowing and chewing occur. Other problems include hearing and visual

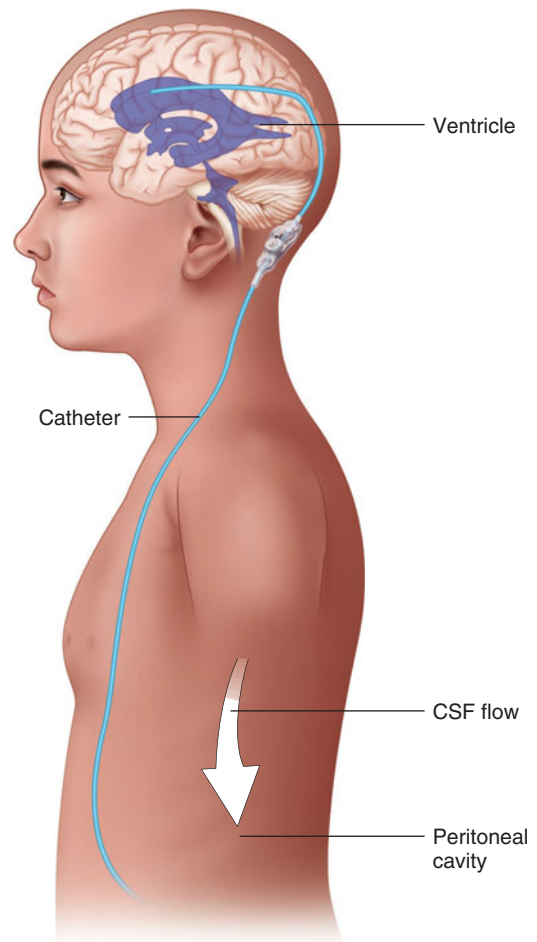


Figure 13–16 ► Position of shunt to drain fluid in hydrocephalus.

impairment, seizures, dental problems, mental and cognitive problems, and incontinence.

Diagnosis depends on physical and neurological exam. CT, MRI, or brain ultrasound may be used to view brain damage. Treatment depends on the nature and the severity of the signs and symptoms. Anticonvulsant drugs reduce seizures and casts or braces may aid walking. In addition, muscle relaxants can relieve spasms along with traction or surgery, which is necessary in some cases. Physical therapy, occupational therapy, and speech therapy are necessary to help people adapt to their disabilities. CP is incurable and a person with CP will need some forms of assistance for life.

CP cannot be prevented, but risk factors can be reduced or eliminated. Good prenatal care can reduce the risk for CP. Expecting mothers should eat a healthy diet, avoid environmental toxins, and treat all infections.

Brain Tumors

Brain tumors are abnormal masses of tissue growing in the brain. An estimated 23,000 new cases occur each year in the United States and about 14,000 people die from brain tumors annually. Malignant and benign tumors occur. Most are benign tumors, but both benign and malignant tumors are serious because they can impair vitally important tissue. Both primary and metastatic tumors occur. Primary brain tumors arise within the brain. Metastatic brain tumors arise from other cancers such as lung, breast, and colon cancers.

Risk factors include increasing age, and race, with more cases occurring among Caucasians. Exposure to chemicals and radiation may increase the risk for tumors. No evidence link brain tumors to electromagnetic radiation from overhead wires or cell phones. Family history is thought to contribute to the risk for brain tumors. The cause is ultimately genetic damage.

Signs and symptoms vary and depend on the area of the brain affected. More frequent and severe headaches, vision loss and double vision, confusion, dizziness, unexplained vomiting, and loss of coordination are all signs and symptoms of a possible brain tumor. Speech and hearing problems and personality changes can also occur.

Diagnosis requires a neurological exam and imaging via MRI and CT (Figure 13–17 ►). Medical treatment may include chemotherapy or

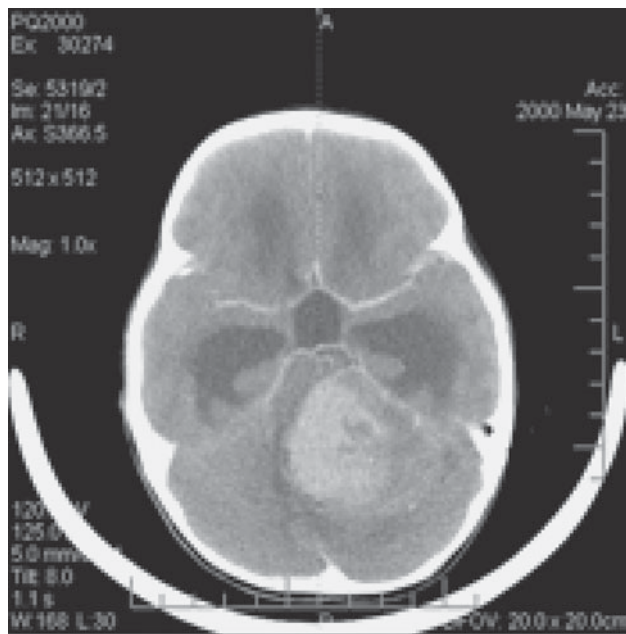


Figure 13–17 ► CT imaging of glioblastoma in a 6-year-old girl. (National Cancer Institute)

immunotherapy. Surgery and radiation may be used. After treatment patients may also need rehabilitation, physical therapy, occupational therapy, and speech therapy.

Age-Related Diseases

With age comes slower reflexes and diminished sense acuity. Memory declines in most people to some degree. In general, the prevalence of degenerative diseases increases with age and infectious diseases are more severe in advanced age. Diseases associated with aging include Alzheimer's, Parkinson's, essential tremor, stroke, and shingles. Middle age is typical onset for ALS, MS, Huntington's, and some cases of Parkinson's. Early-onset Alzheimer's, a genetic form, is known to begin in middle age.

Resources

ALS Association: www.alsa.org
 Alzheimer's Foundation of America www.alzfdn.org
 Mayo Clinic: www.mayoclinic.com
 National Institute of Health: www.nih.gov
 National Parkinson Foundation: www.parkinson.org
 National Stroke Association: www.stroke.org

Diseases at a Glance

Nervous System

Disease	Etiology	Signs and Symptoms
Brain tumor	Idiopathic	Vision impairment, severe headache, personality changes, loss of speech, unsteady movement, seizures, coma
Meningitis	Bacterial, viral	High fever, chills, severe headache, stiff neck, nausea, vomiting, rash, delirium, convulsions, coma
Encephalitis	Viral	Mild to severe headache, fever, cerebral dysfunction, disordered thought, seizures, persistent drowsiness, delirium, coma
Poliomyelitis	Viral	Stiff neck, fever, headache, sore throat, GI disturbances, paralysis may develop
Tetanus	<i>Clostridium tetani</i>	Rigidity of muscles, painful spasms and convulsions, stiff neck, difficulty swallowing, clenched jaws
Botulism	<i>Clostridium botulinum</i>	Muscle weakness; droopy eyelids; difficulty swallowing, speaking, and breathing
Rabies	Viral	Early, no symptoms; later, fever, pain, rage, convulsions, paralysis, profuse sticky saliva, throat muscle spasm produces hydrophobia
Shingles	Varicella, herpes zoster	Painful rash of small, watery blisters with red rim; lesions follow a sensory nerve, confined to one side of body; severe itching; scarring
Reye's syndrome	Idiopathic or viral; Epstein-Barr, influenza B, varicella	Persistent vomiting, rash, lethargy about 1 week after a viral infection, may progress to coma; linked with use of aspirin

Diagnosis	Treatment	Prevention
CT scan, MRI	Surgery, chemotherapy, radiation	None
Lumbar puncture (spinal tap)	Antibiotics if bacterial infection	Vaccination for meningococcal, pneumococcal, and Hib meningitis
Lumbar puncture (spinal tap)	Control fever, control fluid and electrolyte balance, monitor respiratory and kidney function	None, except avoid mosquitoes for West Nile virus encephalitis
Physical exam	Supportive; preventive vaccination	Vaccine
Physical exam, patient history	Antitoxin, symptom relief	Vaccine
Exam and history	Antitoxin	Properly prepare canned foods; do not feed honey to infants
Physical exam, history of animal bite	Vaccination before symptoms develop; fatal once CNS involved	Vaccine; seek medical attention for any animal bite
Physical exam	Alleviation of symptoms and pain relief, steroids	Shingles vaccine; avoid contact with individuals with recent exposure to chickenpox vaccine
Patient history, liver enlargement, hypoglycemia, ammonia in blood	Supportive; close monitoring necessary	Avoid aspirin during viral infection

Disease	Etiology	Signs and Symptoms
Multiple sclerosis (MS)	Idiopathic; suspect viral or autoimmune	Muscle impairment, double vision, loss of balance, poor coordination, tingling and numbing sensation, shaking tremor, muscular weakness, emotional changes, remission and exacerbation
Amyotrophic lateral sclerosis (ALS), or Lou Gehrig's disease	Idiopathic	Disturbed motility; fasciculations; atrophy of muscles in hands, forearms, and legs; impaired speech and swallowing; death from pulmonary failure in 3–4 years
Huntington's disease (Huntington's chorea)	Genetic	Involuntary, rapid, jerky movements; speech loss; difficulty swallowing; personality changes; carelessness; poor judgment; impaired memory; mental incompetence
Epilepsy	Trauma, chemical, idiopathic	Involuntary contractions or series of contraction or staring spells
Spina bifida	Congenital, folate deficiency	Opening in vertebral canal, different degrees of nerve impairment and disability
Hydrocephalus	Congenital, idiopathic	Enlarged head develops
Cerebral palsy	Birth trauma, rubella infection	Muscle contractures and poor muscle coordination, tremor, seizures, visual or auditory impairment, speech defects
Transient ischemic attacks (TIA), "mini strokes"	Ischemia, aneurysm, hypertension	Visual disturbances, transient muscle weakness on one side, sensory loss on one side, slurred speech; attacks last minutes to hours, average 15 minutes
Stroke	Trauma	Severe, sudden headache, muscular weakness or paralysis on one side, disturbance of speech, loss of consciousness
Alzheimer's disease	Idiopathic; some cases genetic	Memory loss, cognitive impairment, emotional changes, confusion
Parkinson's disease	Unknown; death of CNS neurons that produce dopamine and norepinephrine	Tremor, stiffness, uncontrolled muscle movement, difficulty speaking

Diagnosis	Treatment	Prevention
Physical exam, patient history, MRI	None effective; physical therapy and muscle relaxants, steroids, counseling	None
Electromyogram, nerve conduction study, MRI	Supportive	None
Patient history (inherited disease) and physical exam	No cure; treat associated depression, genetic counseling for family	None; genetic tests and counseling permit informed decision making
Observation of seizure, EEG, family history, CT, MRI	Anticonvulsive drugs	Avoid cranial trauma; use helmet or headgear
Physical exam, CT scan, MRI, EEG	Surgical, physical therapy	Folic acid supplements during pregnancy
Physical exam, CT scan, MRI, spinal tap	Implant shunt to drain CSF	Avoid head trauma and treat infections
Physical exam	Muscle relaxants, anticonvulsive drugs, casts, braces, traction, surgery, physical therapy	Unknown; good prenatal care may help
Cerebral angiogram, CT scan	Depends on cause; surgical treatment of blocked vessels	Blood pressure monitoring, seek immediate treatment to avoid a severe stroke
Angiography, CT scan, MRI	Clot-dissolving drugs, surgery, endarterectomy	Control diabetes, hypertension, and high cholesterol; weight loss; stop smoking; maintain regular exercise
History and examination	Supportive care; treat associated depression	None
History and examination	L-dopa, carbidopa, treat associated depression	None

Interactive Exercises

Cases for Critical Thinking

1. J.A. has had a severe headache for the last 12 hours, a fever of 102°F, plus a stiff neck. Following a lumbar puncture, *Streptococcus pneumoniae* was found in the culture along with low sugar levels and higher protein values. What disease best explains these signs and symptoms? What is the prognosis and treatment?
2. J.L. became increasingly forgetful and disoriented around age 65. Before that he was an intelligent, working, and active grandparent. He cannot recall the names of his grandchildren and he gets lost while driving home. What disease may be affecting J.L.?

Multiple Choice

1. What is the cause of rabies?
 - a. bacterium
 - b. virus
 - c. fungus
 - d. tick
2. Which of the following may cause epilepsy?
 - a. a birth trauma
 - b. injury to the brain
 - c. a penetrating head wound
 - d. all of the above
3. Which functions are controlled by the brain stem?
 - a. sensory function
 - b. muscle action
 - c. memory
 - d. heart rate and breathing
4. Which disease is associated with acute inflammation of the first two meninges of the brain and spinal cord?
 - a. thrombophlebitis
 - b. meningitis
 - c. prostatitis
 - d. encephalitis
5. Which of the following is true of polio?
 - a. caused by a virus
 - b. affects sensory neurons
 - c. found in most people by age 80
 - d. wiped out in 1976
6. Which of the following applies to MS?
 - a. occurs only in males
 - b. occurs primarily in east European cultures
 - c. results from a damaged myelin sheath
 - d. affects young adults
7. What disease can be treated with a clot-buster?
 - a. ischemic stroke
 - b. Reye's syndrome
 - c. meningitis
 - d. botulism
8. Which fatal disease is transmitted by an autosomal dominant gene?
 - a. Alzheimer's disease
 - b. Lou Gehrig's disease
 - b. Huntington's chorea
 - c. Parkinson's disease
9. What is the underlying abnormality in Parkinson's disease?
 - a. dopamine deficiency
 - b. no myelin
 - c. autoimmunity
 - d. cerebral blood clot
10. Paul, an otherwise healthy child, has had several short staring spells in which he appears to be in a dreamlike state. Which condition is associated with this?
 - a. multiple sclerosis
 - b. amyotrophic lateral sclerosis
 - c. epilepsy
 - d. meningitis

True or False

- | | |
|--|---|
| <p>_____ 1. Rabies is a viral infection.</p> <p>_____ 2. Polio can be prevented with a vaccine.</p> <p>_____ 3. Rabies is almost always fatal once symptoms appear.</p> <p>_____ 4. Blood is not normally found in cerebrospinal fluid.</p> <p>_____ 5. Dopamine deficiency causes epilepsy.</p> | <p>_____ 6. Ischemic strokes are caused by bleeding or burst blood vessels in the brain.</p> <p>_____ 7. Tetanus can be prevented by a vaccine.</p> <p>_____ 8. Viral meningitis is highly contagious.</p> <p>_____ 9. Most cases of Parkinson's disease are inherited.</p> <p>_____ 10. Shingles is caused by the chicken-pox virus in adults.</p> |
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Fill-Ins

- | | |
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| <p>1. _____, commonly called lock-jaw, is an infection of nerve tissue caused by the tetanus bacillus that lives in the intestines of animals and human beings.</p> <p>2. Meningitis is diagnosed by _____.</p> <p>3. _____ is a chronic, progressive disease of the central nervous system with myelin destruction.</p> <p>4. _____, also known as shaking palsy, is a disease of brain degeneration that appears gradually and progresses slowly.</p> <p>5. The common drug given to victims of Parkinson's disease is _____.</p> | <p>6. _____ is an inflammation of the brain usually caused by viruses.</p> <p>7. Spina bifida can be prevented by taking _____ during pregnancy.</p> <p>8. _____ is caused by inflammation of the facial nerve.</p> <p>9. _____ is called Lou Gehrig's disease.</p> <p>10. _____ are the treatment for meningococcal meningitis.</p> |
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Chapter 14

Diseases and Disorders of the Eye and Ear

Learning Objectives

After studying this chapter, you should be able to

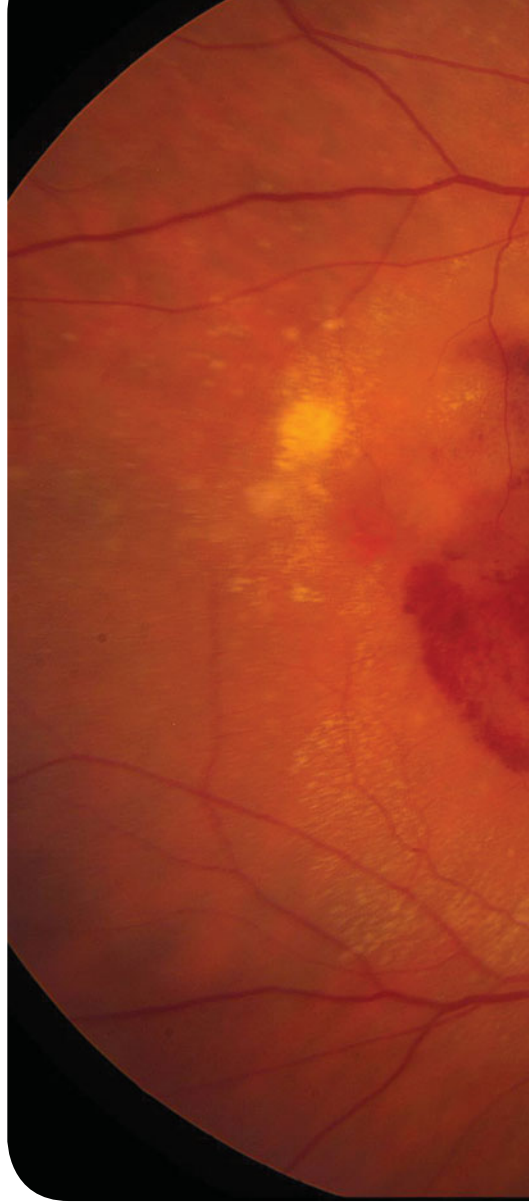
- Recognize the basic structures and functions of the eye and ear
- Describe common visual problems such as myopia and hyperopia
- Discuss the etiology, symptoms, treatment, and prognosis of diseases of the eyelids, the conjunctiva, sclera, uvea, retina, cornea, macula, and lens
- Describe the etiology symptoms, treatment, and prognosis of disorders of the external, middle, and inner ear
- Recognize age-related changes that affect vision and hearing

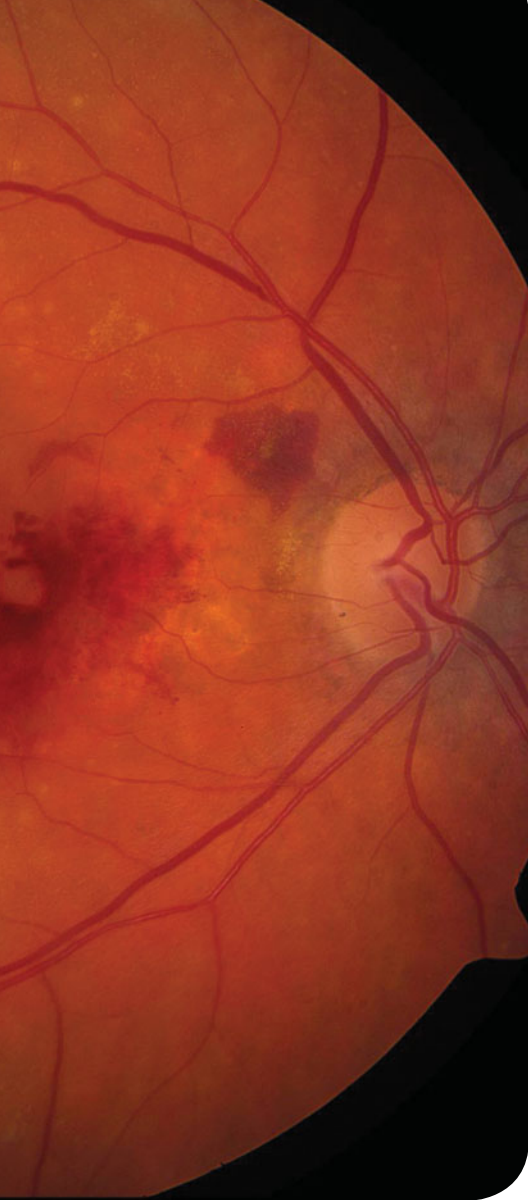
Fact or Fiction?

Blindness is associated with diabetes.

Fact: Diabetes mellitus is associated with vascular disease, which causes diabetic retinopathy and blindness. Retinopathy is a vascular disease of the eye that develops in nearly all individuals with type I diabetes and in about 70% of individuals with type II diabetes.

This view of the rear of the eyeball was obtained using an ophthalmoscope. This image shows the growth of abnormal new blood vessels that occurs in age-related macular degeneration. (National Eye Institute, National Institutes of Health)





Disease Chronicle

Helen Keller (June 27, 1880 to June 1, 1968)

Helen Keller, an American author, activist, and lecturer, was the first deaf/blind person to graduate from college. At about 2 years of age, Helen contracted an infection with a high fever. Following her illness, Helen lost her sight and hearing. With the help of her teacher, Anne Sullivan, Helen learned several methods of communication, including touch-lip reading, Braille, speech, and typing, and attended Horace Mann School for the Deaf, Wright-Humason School for the Deaf, Cambridge School for Young Ladies, and Radcliffe College. Helen Keller graduated from college determined to improve the lives of others. She published 12 books, was a founding member of the American Civil Liberties Union, and was a tireless advocate for people with disabilities.

Anatomy and Physiology Review: the Eye

The eyes receive and focus light on light-sensitive receptors and transmit nerve impulses to the brain, where information is interpreted to form images. Several structures within and near the eyeball enable the eyes to function (Figure 14-1 ►).

The eyeball is roughly spherical and is protected by bones of the skull. Three layers of the eyeball are the sclera, uvea, and retina. The sclera is fibrous connective tissue that lends shape and support to the eyeball. The visible white of the eye is composed of sclera. Beneath the sclera lies the uvea, a vascular layer. The uvea provides oxygen and nutrients to the innermost layer of the eyeball, the retina. The inner and posterior layer is the retina, which contains light-sensitive nerve endings known as photoreceptors. The center of the retina is the macula, an area with a high density of photoreceptors. The macula is responsible for acute vision.

A thick fluid called the vitreous humor fills the eyeball posterior to the lens. This thick fluid helps maintain the eyeball shape. Another fluid, the aqueous humor, fills the space in front of the lens.

The anterior surface of the eyeball is covered by the cornea. The cornea is a curved, transparent

structure in front of the lens. Light entering the eye first passes through the cornea. Posterior to the cornea lies the lens, a transparent biconcave structure composed of protein. The lens focuses light onto the retina. In front of the lens lies the iris, a flattened disc with a central opening called the pupil. Light passes through the pupil to the lens. The iris is capable of changing the diameter of the pupil opening to adjust the amount of light entering the eye. A wide pupil is said to be dilated, and it permits more light to enter the eye. A narrow pupil is described as constricted, and it permits little light to enter the eye.

Attached to the eyeball are various extrinsic eye muscles that control eyeball movement. In front of the eyeball are eyelids, skin-covered flaps that can close and protect the eye surface. Tear glands secrete lubricating fluid onto the outer surface of the eye.

Diagnostic Tests and Procedures: the Eye

Diagnosis of eye diseases and disorders relies on physical examination using instrumentation. The interior of the eye can be observed using an ophthalmoscope, which reveals the condition of the retina, macula, lens, and cornea. The pupils may be dilated with a medication to help view the inside of the eye. External physical exams

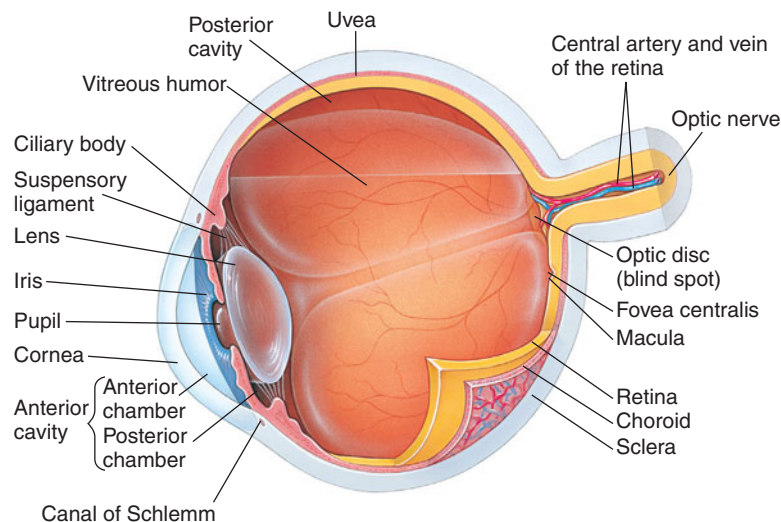


Figure 14-1 ► Human eye anatomy.

reveal inflammation and infection. Tonometry measures eyeball pressure to detect glaucoma. A Snellen eye chart can be used to assess visual acuity.

Diseases and Disorders of the Eye

Diseases and disorders of the eye can impair vision and significantly affect quality of life.

Refractive Errors

Refractive errors produce improperly focused light on the retina, which results in blurry images. Refractive errors are the most common

vision problems in the United States. More than 34 million American adults have myopia (near-sightedness) and more than 14 million adults have hyperopia (farsightedness). Refractive distortions include myopia, hyperopia, presbyopia, and astigmatism (Figure 14-2 ►).

Myopia and Hyperopia Myopia is known as near-sightedness, a condition in which the eye can focus on close objects but cannot form focused images of distant objects. In hyperopia, known as farsightedness, distant vision remains good, but the eye cannot form focused images of close objects. The most important risk factor for these is family history because these conditions are inherited. The cause is related to eyeball shape.

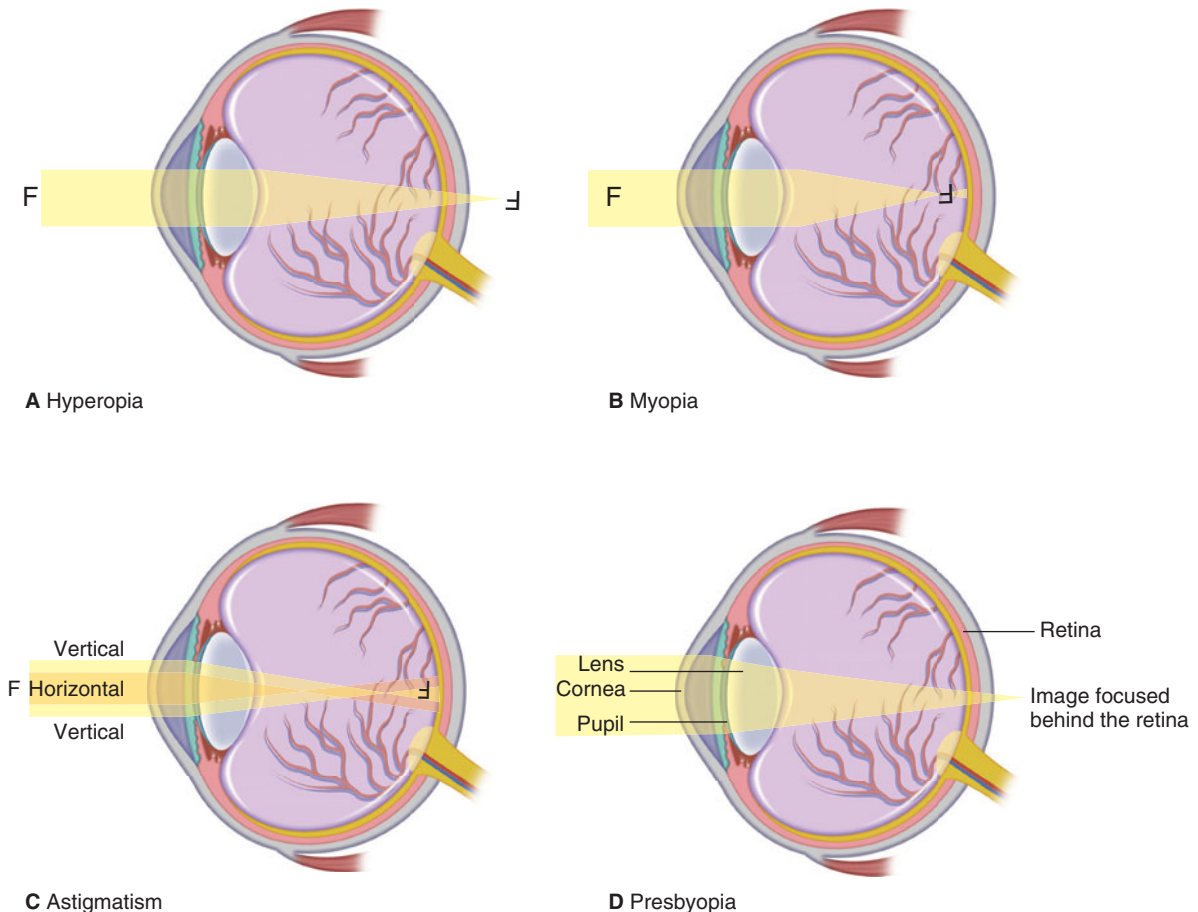


Figure 14-2 ► (A) In hyperopia, light rays focus behind the retina, making it difficult to focus on objects at close range. (B) In myopia, light rays focus in front of the retina, making it difficult to focus on objects that are far away. (C) In astigmatism, light rays do not uniformly focus on the eye due to abnormal curvature of the cornea or lens. (D) In presbyopia, the aging lens becomes rigid and is unable to focus light from close objects.

In myopia, the eyeball grows too long and distant images focus short of the retina. In hyperopia, the eyeball is too short, and distant images focus behind the retina while close images fall unfocused on the retina.

Diagnosis is based on the Snellen eye chart, a test for visual acuity, and on physical exam of the eye. Myopia is treated with concave lenses and hyperopia is treated with convex lenses. Laser surgery on the cornea can also be used to shape the cornea and correct myopia or hyperopia.

Presbyopia Presbyopia is an age-related refractive disorder in which the eye cannot focus on close objects. Presbyopia can occur alone or with myopia, hyperopia, or astigmatism. About 9% of Americans have presbyopia. The risk factors are age and family history. After age 35 some people develop a small amount of presbyopia and it usually becomes noticeable in the late 40s. Presbyopia is caused by age-related reduction in lens flexibility. Symptoms include the inability to read small print and focus on near objects.

Diagnosis uses a dilated eye exam and Snellen eye chart. Most cases can be treated with inexpensive nonprescription reading glasses that simply magnify close objects. Eyeglasses can also be fitted with lenses that magnify in the bottom portions of the lens.

Astigmatism A cornea with surface irregularities, such as asymmetry or uneven thickness, causes astigmatism. Light passing through the region of an irregularity falls unfocused on the retina, resulting in an image with blurry regions. Risk factors include a family history of astigmatism. Symptoms are images that are blurry but recognizable at different distances.

Astigmatism can be diagnosed with an eye exam and Snellen eye chart. Most cases of astigmatism can be treated with corrective eyeglasses or contact lenses.

Retinal Image Defects

Diabetic Retinopathy Diabetic retinopathy (DR) is the leading cause of blindness among adults in the United States. The chief risk factor for DR is diabetes mellitus, which damages blood vessels, including the vessels that nourish the retinas of the eyes. About 40% of diabetes type 1 patients

will be diagnosed with DR within 3 years of diabetes diagnosis. About 20% of people with diabetes type 2 have some degree of retinopathy at the time of diagnosis. Pregnant women are also at risk for DR if they develop gestational diabetes.

Signs and symptoms include vascular changes in the retina, loss of visual acuity, and diminished night vision. Diabetic retinopathy can be diagnosed with an eye exam using an ophthalmoscope to examine the retina. Treatment is limited, but vessel hemorrhages can be stemmed using laser surgery. Prevention requires annual eye exams and treatment of diabetes and hypertension.

Macular Degeneration Macular degeneration results in the reduction or loss of acute vision. It is fairly common and is a leading cause of vision loss in adults. Macular degeneration affects the central part of the retina with the highest density of photoreceptors, the part that forms sharp images. As a result, macular degeneration affects central vision and leaves peripheral vision intact. Two forms of macular degeneration are the atrophic (dry) form, comprising more than 90% of cases, and the exudative (wet, hemorrhagic) type, a more destructive form. In the dry form, the macular area degenerates. In the wet form, capillaries growing under the macula leak and disrupt the macula.

Causes for macular degeneration are not well understood, but it is known that obstructed blood flow, followed by revascularization, damages the area of the retina responsible for acute vision. Other contributing factors are injury, inflammation, infection, and heredity. Risk factors include age, family history, and smoking. Macular degeneration usually occurs after age 50. (See Figure 14–3 ►.) Signs and symptoms include inability to see faces clearly, difficulty reading, and problems performing close work such as sewing or repairing machinery.

Diagnosis requires a dilated eye exam with ophthalmoscope. An Amsler grid, composed of a grid of fine lines, can detect distorted, incomplete, or wavy images in the central vision field. Fluorescein angiography, using a dye injected intravenously and a special camera, reveals leaking vessels below the retina.

There is no cure for macular degeneration. Some reduction of wet macular degeneration can

Promote Your Health

Macular Degeneration

Macular degeneration can be devastating, but its progress can be slowed and managed. Early detection is key to effective intervention. Examination by an eye doctor

should be a regular part of an aging person's health care, especially if macular degeneration has affected close family members.

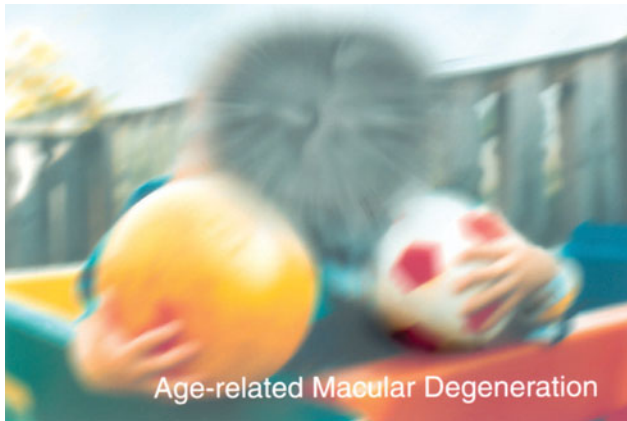


Figure 14-3 ► Simulated vision with macular degeneration. (National Eye Institute, National Institutes of Health)

be achieved with laser surgery. Vitamin supplementation may help slow dry macular degeneration, but this should only be done under a doctor's supervision. For a few patients, surgical implant of a telescopic lens can improve central vision. Macular degeneration cannot be prevented, although some risk factors, such as smoking, can be controlled.

Retinal Detachment Retinal detachment is an emergency condition in which the retina pulls away from the back of the eyeball. It can result in blindness in the affected eye because the underlying layer of the eyeball provides oxygen and nutrients to the retina. Risk factors include aging, extreme nearsightedness, advanced diabetes, and eye trauma.

Signs and symptoms include sudden appearance of floaters (floating debris) in the affected eye. Sudden flashes of light or dark shadows like a curtain also indicate a retinal detachment. Diagnosis requires a history and ophthalmoscopic exam of the eye and may include

an ultrasound of the eye. Treatment usually involves laser surgery or injection of gas or fluid into the eye to press the retina back into place. Retinal detachment cannot be prevented.

Glaucoma

Glaucoma is a condition of increased pressure within the eye (Figure 14-4 ►). This painless condition damages the optic nerve and is a leading cause of blindness in the United States. More than 2 million Americans have glaucoma. The risk for glaucoma is highest among people over age 60, especially Mexican Americans, and over age 40, especially African Americans. Family history also increases the risk for glaucoma. The cause remains unknown, but it is related to fluid pressure building within the eyeball.

Signs and symptoms are not noticed until vision loss occurs. The diagnosis of glaucoma includes tonometry, which measures intraocular pressure. Visual field testing measures the field peripheral vision. Corneal thickness can cause high-pressure



Figure 14-4 ► Simulated glaucoma. (National Eye Institute, National Institutes of Health)

readings in people who do not have glaucoma. Pachymetry, which measures the thickness of the cornea, prevents this kind of misdiagnosis.

Treatments for glaucoma are aimed at decreasing intraocular pressure and include medications and laser surgery. Medicated eye drops reduce the production of fluid and promote fluid drainage. Laser surgery involves piercing the anterior chamber with a laser beam to promote drainage and reduce pressure. Glaucoma cannot be cured, and its damage cannot be reversed.

Glaucoma is not preventable, but early detection allows early treatment to prevent serious damage. Regular eye exams that include evaluation of intraocular pressure can help identify developing disease. Risks for glaucoma can be reduced by controlling blood sugar and hypertension and by getting regular eye exams.

Cataracts

A cataract is a clouding of the lens. Most cataracts are related to aging (Figure 14-5 ►). By age 65, almost half of all Americans have some degree of cataract formation and resulting impaired vision; after age 75 the figure is close to 70%. Risk factors for cataracts include trauma, smoking, alcohol use, exposure to radiation or ultraviolet rays, systemic diseases such as diabetes or hypertension, poor nutrition, and intrauterine infections.



Figure 14-5 ► Simulated cataracts. (National Eye Institute, National Institutes of Health)

Symptoms of cataracts depend on the extent of lens opacity and whether one or both eyes are affected. Age-associated cataracts occur in both eyes, whereas congenital cataracts may occur in one eye. Visual impairment includes visual distortion, blurred vision, and glare, especially in bright light or when driving at night. In early stages, a cataract can be seen through a dilated pupil with an ophthalmoscope or slit lamp. As the cataract continues to develop, the retina becomes more difficult to visualize and the pupil develops white discoloration.

Diagnosis can be accomplished in a routine eye exam using ophthalmoscopy. Early detection allows planning for treatment or preventative measures to reduce the progression of cataracts. Outpatient lens replacement surgery has become a routine procedure, and vision is restored to normal in 95% of patients. Prevention is almost impossible because this is a condition related to aging (See Figure 14-4).

Infectious and Inflammatory Diseases

Conjunctivitis Conjunctivitis is an inflammation of the conjunctiva, the superficial covering of the sclera (white of the eye), and the inner linings of the eyelids (Figure 14-6 ►). About 30% of all eye complaints are for conjunctivitis, commonly called “pink eye,” yet many cases go unreported. Risk factors include age, because most cases occur among children. Symptoms include red, swollen eyes with discharge.



Figure 14-6 ► Conjunctivitis. (© Dorling Kindersley)

Conjunctivitis can be caused by bacteria, viruses, or irritating chemicals. Viral and bacterial infections are contagious, so children with conjunctivitis are instructed to stay home from school or social activities.

Signs and symptoms of bacterial conjunctivitis include itchy, light-sensitive, red eyes with yellow or white discharge. Viral infections produce watery discharge. Reinfection occurs by rubbing or touching the eye with contaminated hands. Often the inflammation resolves within 2 weeks. A type of conjunctivitis called inclusion conjunctivitis is sometimes present in newborns. It is caused by *Chlamydia trachomatis* and is usually transmitted during childbirth when a mother has a vaginal chlamydia infection.

Conjunctivitis is usually diagnosed with examination and history. Treatment includes antibiotic drops for bacterial conjunctivitis. Viral conjunctivitis cannot be treated.

Prevention of conjunctivitis is best achieved by reducing hand-to-eye contact, disposing of contaminated materials such as contact lenses and beauty products (e.g., mascara), and avoiding known chemical triggers.

Keratitis Keratitis is inflammation of the cornea caused by infection with bacteria, viruses, fungi, or other parasites. The prevalence is unknown, but keratitis is not common. The risk factors include injuries such as abrasions, immune deficiency, or genital herpes infections. Signs and symptoms are pain and inflammation.

Diagnosis requires examination of the cornea and culture of pathogens. Treatment depends on the nature of the pathogen. Antibiotics, antifungal agents, or antiviral agents may be used. Prompt treatment can prevent corneal scarring and vision loss. Prevention includes wearing protective eyewear when indicated, as when working with power tools. Contact lenses should be maintained in clean condition and discarded when scratched. Lens cases should be disinfected regularly and replaced periodically. Underlying herpes infections should be treated and controlled so that they cannot spread to the cornea.

Uveitis Uveitis is inflammation of the uvea, the vascular layer of the eyeball. Uveitis is not uncommon, affecting about 38,000 people annually in the United States. Risk factors include

an immune deficiency. In HIV/AIDS, uveitis is caused by cytomegalovirus, herpes simplex, *Toxoplasma*, and *Candida*.

Signs and symptoms include pain, redness, photophobia, and blurred vision. Uveitis can be treated with corticosteroids and systemic or topical medications, depending on the location and type of pathogen. Posterior uveitis requires treatment with systemic medications or corticosteroids injected within the eye. Uveitis is difficult to prevent except by controlling the condition of immune deficiency.

Eyelid Infections One of the most noticeable lesions found on the eyelid is the common **stye** or **hordeolum**. The precise incidence of the common stye is difficult to determine because many individuals do not seek treatment for these lesions. The etiology of a hordeolum is infection with staphylococcus bacteria, which trigger abscess formation on the upper and lower eyelid. Symptoms generally include redness, pain, and swelling with a foreign-body sensation on the eye. Small styes tend to develop on the external eyelid surface and margin. Internal styes project toward the surface of the eye. A stye may rupture and resolve spontaneously. Large lesions may reduce the field of vision and require mechanical excision. Styes can be cleaned gently with a soft washcloth. They may require treatment with antibiotic eye drops. Prevention requires good hand hygiene and avoiding hand-eye contact.

Impaired Color Vision and Color Blindness

Color vision is made possible by photoreceptors in the retina called *cones*. These are sensitive to certain wavelengths of light that are associated with different colors. Inherited deficiencies in these cones cause various degrees of impaired color vision. Most people with impaired color vision cannot distinguish shades of red and green. The prevalence of this type is about 1 in 12 males of northern European ancestry but it is lower in other ethnic groups. Some people with impaired color vision cannot distinguish shades of blue and yellow. This affects about 1 in 10,000 people worldwide. Complete absence of color vision is called *color blindness* and is rare, affecting 1 in 30,000 people worldwide. Color

blind people see only shades of gray. Color vision impairments and color blindness are carried on the X chromosome, so these occur more often in males, although females can inherit the condition too. Color blindness can be diagnosed with a multicolored, spotted eye chart in which colored numbers are embedded and visible to those with normal color vision. There is no treatment for impaired color vision and it cannot be prevented.

Ocular Tumors

Retinoblastoma Retinoblastoma is a rare, recessively inherited childhood tumor of the retina. Risk factors include family history. Approximately 40% of retinoblastomas are inherited, with carriers of the mutant gene having a 10,000-fold increased risk for the development of retinoblastoma. Retinoblastoma generally affects children under 6 years of age and is most commonly diagnosed during the first 2 years of life.

Symptoms can include crossed eyes, eye pain, redness, and appearance of a white reflex in the pupil called **leukocoria** or “cat’s-eye reflex.” Diagnosis requires ultrasound, MRI, CT, and eye exam. Treatment of retinoblastoma is aimed at preserving vision, destroying the tumor, and monitoring for metastasis. Chemotherapy and surgery can reduce or remove small and localized tumors. Large tumors are treated by removal of the affected eye(s) with as much of the optic nerve as necessary. About 90% of cases of intraocular tumors can be cured. In contrast, metastatic retinoblastoma tends to spread to the brain and bone marrow and is associated with a poor prognosis.

In children at risk, prevention requires examinations every 2–4 months for 2 years to screen for the development of additional tumors. Genetic counseling can help families understand the genetic consequences of retinoblastoma and estimate the risk of disease in family members.

Anatomy and Physiology Review: the Ear

The ear is the organ of hearing and balance. It is composed of three regions: an outer ear, middle ear, and inner ear. The portion of the outer ear that is external to the skull is called the pinna; it is covered by skin and supported by cartilage.

The pinna directs sound into the auditory canal, a skin-lined tube that leads to the middle ear. The innermost part of the auditory canal is also lined with glands that secrete cerumen, a waxy substance that keeps the tympanic membrane soft and flexible.

The middle ear begins at the tympanic membrane (ear drum), a fibrous tissue that spans the auditory canal. Sound waves trigger vibrations of the tympanic membrane, which transmits the vibrations to three middle-ear bones, the auditory ossicles. The ossicles are the malleus, incus, and stapes. The stapes vibrates against an opening in the cochlea, a snail-shaped organ within the inner ear. Vibrations moving through the fluid of the cochlea stimulate specialized structures called *hair cells*, which transmit information about the vibrations along the auditory nerve to the brain for interpretation.

Within the inner ear is the vestibular apparatus and semicircular canals, which are sensitive to head position and motion and thus give the brain information for maintaining balance (Figure 14–7 ►).

Diagnostic Tests and Procedures: the Ear

External exam reveals conditions of the external ear and auditory canal. An otoscope permits visualization of the auditory canal and the condition of the tympanic membrane. Hearing tests utilize head phones or tuning forks to assess hearing and the causes of hearing loss.

Diseases and Disorders of the Ear

Diseases and Disorders of the External Ear

Cerumen Impaction As already noted, cerumen keeps the tympanic membrane soft and flexible. However, cerumen impaction (excess wax buildup) may occur. In most people cerumen that is secreted slowly moves to the outer ear and flakes off. Some people produce excessive cerumen that builds up within the ear. Signs and symptoms of impaction are ringing in the ear (tinnitus), earache, or diminished hearing

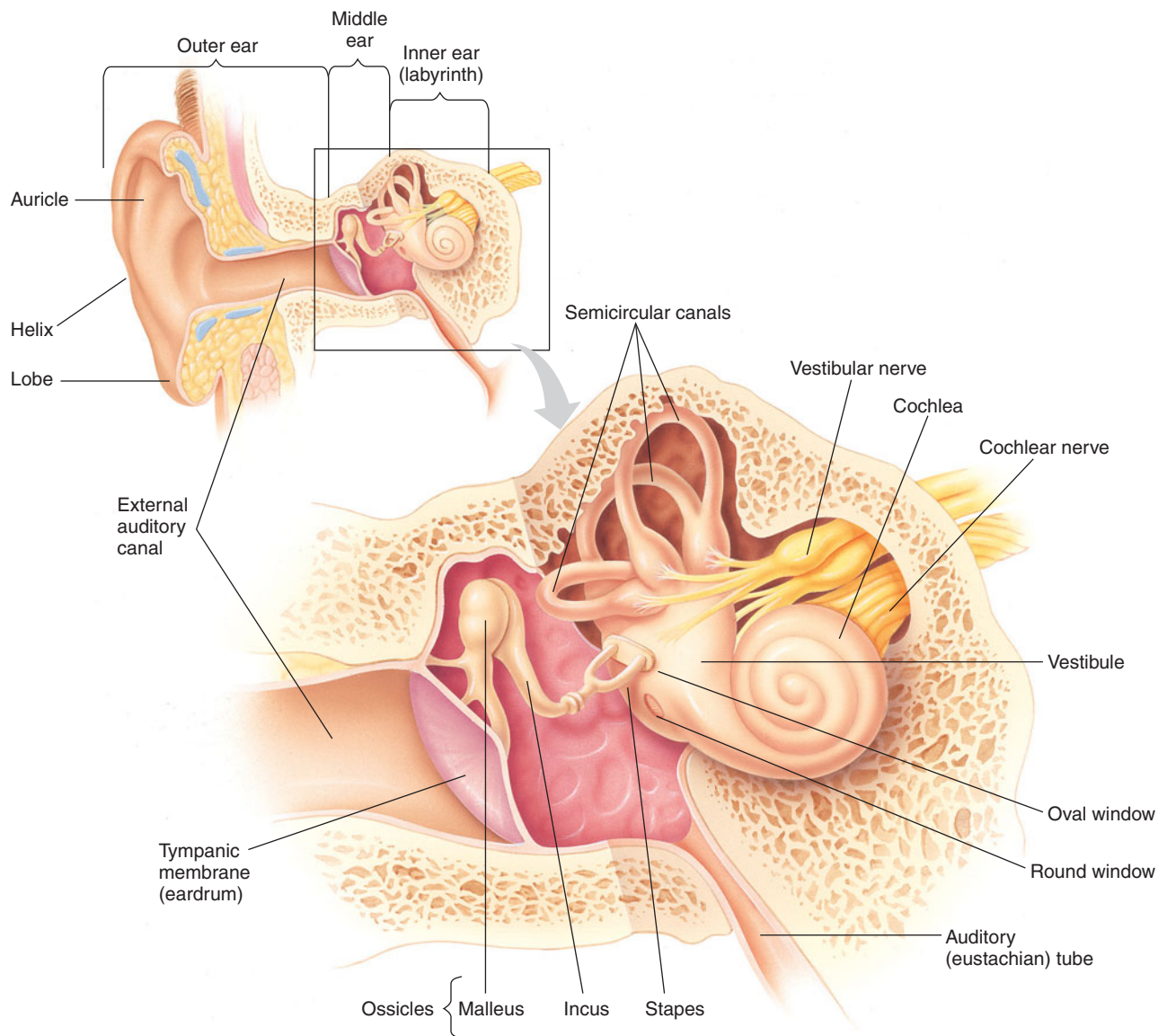


Figure 14-7 ► Human ear anatomy.

in the affected ear. Treatment should be done by a doctor because the tympanic membrane is delicate and can be easily injured while removing impacted cerumen.

To prevent impaction, the ear should not be cleaned with cotton swabs, which usually push cerumen deeper and against the tympanic membrane. If buildup is excessive, a doctor may recommend occasionally applying baby oil or hydrogen peroxide to soften the cerumen, followed by warm water to flush it out.

Otitis Externa Otitis externa, or “swimmer’s ear,” is an infection of the auditory canal caused by bacteria and fungi. The prevalence is unknown, but a chief risk factor is swimming. It is usually caused by water remaining in the external ear after swimming. It can also be caused by abrasion of the external auditory canal. Symptoms and signs include pain, itching, redness, and discharge. If advanced, the infection may cause fever and temporary hearing loss. Otitis externa can be diagnosed by physical exam of the ear.

Diagnosis might require culture of the pathogen to determine the best treatment. Otitis externa is treated with antibiotics or antifungal medications and analgesics.

Otitis externa can be prevented by drying the external ear opening after bathing or swimming. Foreign objects should not be inserted into the auditory canal. Earphones and earplugs should be cleaned regularly.

Diseases and Disorders of the Middle Ear

Otitis Media Otitis media is a middle ear infection. More than 5 million cases of acute otitis media occur among children in the United States each year. Age is the main risk factor for otitis media, which affects mainly infants and children. Children are more susceptible than adults because their nearly horizontal auditory tubes prevent adequate drainage. Bacteria and viruses cause most cases of otitis media.

Symptoms include pain, swelling, edema, and pus. Severe swelling may perforate the tympanic membrane. Diagnosis is based on the observation of a bulging tympanic membrane and effusion (pus and fluids). In healthy children, most cases resolve on their own. For a bacterial infection, antibiotics may be prescribed. Pain can be controlled with analgesics such as acetaminophen or ibuprofen. Aspirin should never be given to children. Recurrent or chronic infection may require small ear tubes (tympanostomy tubes)

in the tympanic membrane that assist drainage and prevent recurrence.

Difficult to prevent, the risk for otitis media can be reduced by avoiding exposure to smoking and air pollution. Breastfeeding infants until 6 months of age has been shown to reduce the incidence of otitis media.

Diseases and Disorders of the Inner Ear

Hearing Loss Presbycusis is age-related hearing loss and is the most common cause of hearing loss in adults. Presbycusis occurs in a third of adults age 65–75 and half of those over age 75. The risk factors include increasing age, family history of presbycusis, repeated exposure to loud noises, smoking, and certain medical conditions. Signs and symptoms include difficulty understanding conversations, especially in a noisy room. Those with hearing loss may withdraw from social situations to avoid hearing problems. Tinnitus and inability to hear high pitches are also signs of presbycusis. Presbycusis can be diagnosed with routine hearing tests and tuning forks. Treatment may include hearing aids if the auditory nerve and cochlea remain functional.

The degree of age-related hearing loss can be prevented by reducing exposure to loud noises or by using ear plugs and ear protection when exposed to loud noises. Other causes of hearing loss include trauma, high fever, toxins, certain antibiotics, and infections. Genetic causes of hearing impairment or deafness may be noted in newborns.

Prevention PLUS!

Turn down the volume of noise at home, work, and play. Your lawnmower, leaf blower, and chainsaw produce damaging levels of noise. Each exposure to such loud noises damages your ears. Hearing protectors can help reduce dangerous noise in areas where noise cannot be controlled or eliminated.

Think Critically

1. How do loud noises lead to hearing loss?
2. How can you tell if hearing loss is caused by nerve problems or by problems with middle ear ossicles?

Meniere's Disease Meniere's disease is a condition of intermittent hearing impairment, tinnitus, and vertigo (dizziness). Meniere's disease is not uncommon; it affects more than 600,000 people in the United States annually, mainly people age 40–60, but it can occur at any age. The cause is unknown, although it could be an autoimmune or inflammatory disease. Fluid accumulation in the inner ear is responsible for its signs and symptoms,

The main symptoms of Meniere's disease are sudden episodes of vertigo that may last 20 minutes, intermittent hearing loss, tinnitus, and pressure in the ear. Diagnosis requires a physical exam, hearing test, and specialized tests for vertigo. There is no cure for Meniere's disease. Treatment is symptomatic and includes medications for vertigo.

Some cases are treated with diuretics and anti-inflammatory drugs. Meniere's disease cannot be prevented.

Age-Related Diseases and Disorders

Age-related changes in vision include loss of visual acuity and decreased sensitivity to light. With age the curvature of the cornea decreases, impairing refraction and its ability to focus light. With age the lens increases in thickness and decreases in elasticity, making it more difficult to accommodate and focus on objects at a close distance. A thickened lens becomes less transparent and admits less light into the eye.

Age-related hearing loss is especially pronounced at high frequencies. Alterations in sound receptors, neurons, and blood supply to the inner ear are among the changes associated with age.

Changes in vision and hearing can be managed with surgical procedures, eyeglasses, and hearing aids. Older adults may not like using hearing devices or eyeglasses because of cost and embarrassment about these signs of aging. However, vision and hearing impairment, balance problems, and reduced muscle strength and coordination contribute to falls among aging adults. Falls are a leading cause of injury in older adults. Keeping sight and hearing as acute as possible can help prevent injuries from falls and other causes.

Diseases at a Glance

The Eye and Ear

Disease	Etiology	Signs and Symptoms
Eye		
Myopia	Thickening of the lens	Blurring of distant vision
Hyperopia	Stiffening of the lens of the eye	Distant vision is intact, closeup vision is blurred
Presbyopia	Reduction in the ability to focus images on the retina	Closeup vision is blurred
Styes	Bacteria	Redness, pain, swelling, with a foreign body sensation
Conjunctivitis	Viruses, bacteria, fungi	Swelling inflammation, redness
Keratitis	Bacteria, viruses, fungi	Pain, swelling, inflammation
Glaucoma	Increased pressure within eyeball	Painless during early stages. Later, optic nerve damage and reduced visual field
Cataracts	Clouding of the lens	Visual distortion, blurred vision, and glare
Uveitis	Intraocular inflammation, immune processes, viruses, bacteria	Pain, redness, photophobia, and blurred vision
Macular degeneration	Unknown; may be caused by impaired blood flow, infection, or injury to the eye	Loss of vision in the center of the visual field; difficulties recognizing faces or reading
Diabetic retinopathy	Type I and type II diabetes mellitus	Visual impairment, vision loss

Diagnosis	Treatment	Prevention
Vision exam	Correct glasses, contact lenses, Lasik surgery	None
Vision exam	Correct glasses, contact lenses, Lasik surgery	None
Vision exam	Corrective lenses, bifocals, or trifocals	None
Physical exam	Application of warm compresses, topical antibacterial ointment	None; hygiene to prevent bacterial inoculation on the eye
Ophthalmologic exam	Antibiotic eye drops for bacterial infections	Hand hygiene, avoid eye contact
Ophthalmologic exam	Topical antibacterial eye drops or ointment or antiviral or antifungal medications	Disinfect contact lenses
Tonometry, visual field testing, exam with ophthalmoscope	Medicated eye drops that decrease the production of fluid or enhance drainage of fluid in the eye	Regular eye exams to identify increases in intraocular pressure; control risk factors such as blood glucose in diabetes, blood pressure
Ophthalmoscopy	Outpatient surgery	Regular eye exams to monitor for age-related changes that lead to cataracts
Ophthalmoscopy	Depending on the etiology; antimicrobial drops or corticosteroid therapy for posterior uveitis	Control of etiological diseases such as those associated with HIV such as cytomegalovirus, HSV, toxoplasmosis
Ophthalmoscopy	Laser treatment to cause photocoagulation	Regular eye exams to monitor progression and to plan for assistive measures
Ophthalmoscopy	Laser treatment to cause photocoagulation	Regular eye exams to monitor progression and to plan for assistive measures

Disease	Etiology	Signs and Symptoms
Retinoblastoma	Genetics	Crossed eyes, eye pain
Ear		
Otitis media	Bacteria, viruses	Ear pain, pus, fluid in the ear
Presbycusis	Age-related hearing loss, repeated exposure to noise	Reduced hearing acuity and inability to distinguish high-pitched sound
Meniere's disease	Idiopathic	Vertigo, intermittent hearing loss, tinnitus

Diagnosis	Treatment	Prevention
Ophthalmoscopy under anesthesia, CT, MRI scan	Chemotherapy, radiation, surgery	Genetic counseling in families with affected member
Observation of bulging ear drum and fluids, pus in middle ear	Most resolve on own; some require antibiotics	None; breastfeeding to 6 months reduces risk
Audiology testing	Hearing aids	Avoid exposure to loud noises, use ear plugs and ear protection
Audiology testing, MRI or CT scans to rule out other causes of vertigo or tinnitus	Treatment of symptoms such as vertigo with medications that reduce inflammation	Minimize the effects of trauma or autoimmune disease

Interactive Exercises

Cases for Critical Thinking

1. J.R. is a 28-year-old male with a history of type 1 diabetes mellitus. He was diagnosed with diabetes at 5 years of age and uses insulin injections to control his blood sugar. J.R. states that his diabetes is currently controlled; however, he had difficulty managing his blood sugar during his teen years. J.R. currently wears glasses to see distant objects. During a recent eye exam, he had his eye pressure checked, and the doctor indicated that his pressure is slightly increased. J.R. is also being monitored for changes in his blood pressure and potential blood clots. Is J.R.'s vision problems related to his diabetes? What problems are associated with elevated eye pressure?
2. A.S. is a 20-year-old college student who presents to the health clinic for "pink eye." She currently lives in a dorm and shares a suite with three other women. Other women in the dorm do not have any symptoms of pink eye, but A.S. was encouraged by her suite mates to get treatment because they believe that pink eye is highly contagious. A.S. currently wears contact lenses and was instructed to remove them and use glasses. A.S. has been waiting to change her extended-wear contacts because she currently does not have enough money to purchase a new box. What can A.S. do to prevent reinfection with pink eye? What treatment should A.S. expect to receive?
3. T.C. complained of an earache, and after a recent bout with a bad cold, he was rather irritable. The ear was "beet red" and felt warm. He could hardly hear on that side, but he knew there was nothing intentionally or accidentally poked into the ear. What disease best explains these symptoms? Give some recommendations for treatment.

Multiple Choice

1. A bulging tympanic membrane and pus in the middle ear are signs of _____.
 - a. external otitis
 - b. tinnitus
 - c. otitis media
 - d. Meniere's disease
2. An infection of the cornea is known as _____.
 - a. retinitis
 - b. conjunctivitis
 - c. uveitis
 - d. keratitis
3. Lens replacement surgery is used to treat _____.
 - a. astigmatism
 - b. glaucoma
 - c. cataracts
 - d. retinoblastoma
4. A condition in which near objects are clear and sharp while distant objects are blurred is known as _____.
 - a. glaucoma
 - b. hyperopia
 - c. myopia
 - d. presbyopia
5. Elevated pressure in the eyeball is the chief sign of _____.
 - a. keratitis
 - b. uveitis
 - c. glaucoma
 - d. cataracts

6. Damage to the vestibulocochlear nerve can result in _____.
 - a. blindness
 - b. impaired color vision
 - c. hearing loss
 - d. Meniere's disease
7. Age-related hearing loss is also called _____.
 - a. presbycusis
 - b. otitis media
 - c. vertigo
 - d. tinnitus
8. Which of the following tests is used to screen for glaucoma?
 - a. CT
 - b. slit lamp
 - c. tonometry
 - d. ophthalmoscope
9. Which of the following disorders is associated with vertigo and tinnitus?
 - a. otitis externa
 - b. presbycusis
 - c. Meniere's disease
 - d. mastoiditis
10. Laser surgery on the cornea is commonly used to correct which of the following eye problems?
 - a. myopia
 - b. cataracts
 - c. glaucoma
 - d. macular degeneration

True or False

- _____ 1. Myopia is also known as farsightedness.
- _____ 2. A common styne is also known as conjunctivitis.
- _____ 3. A cataract refers to a clouded lens.
- _____ 4. Glaucoma is painless in its early stages.
- _____ 5. Conjunctivitis is commonly caused by bacteria.
- _____ 6. Bacterial keratitis may be caused by improper disinfection of contact lenses.
- _____ 7. Increased pressure in the eyeball is the cause of glaucoma.
- _____ 8. Laser surgery can be used to treat glaucoma.
- _____ 9. Cytomegalovirus can cause uveitis in individuals with HIV.
- _____ 10. Baby oil is used to soften impacted cerumen.

Fill-Ins

1. The cochlea is responsible for the sense of _____.
2. The _____ located in the inner ear along with the cerebellum help maintain balance.
3. The external part of the ear that enhances hearing perception is known as the _____.
4. Ringing of the ears is also called _____.
5. A hereditary tumor in the eye commonly diagnosed in children younger than 2 years of age is called _____.
6. The _____ is infected in keratitis.
7. The _____ is the transparent membrane that covers the eye and contributes to the refraction of light.
8. _____ refers to a sense of dizziness.
9. Clouding of the lens is also known as _____.
10. A retinal image defect that develops in the center of the retina is known as _____.

Chapter 15

Mental Disorders

Learning Objectives

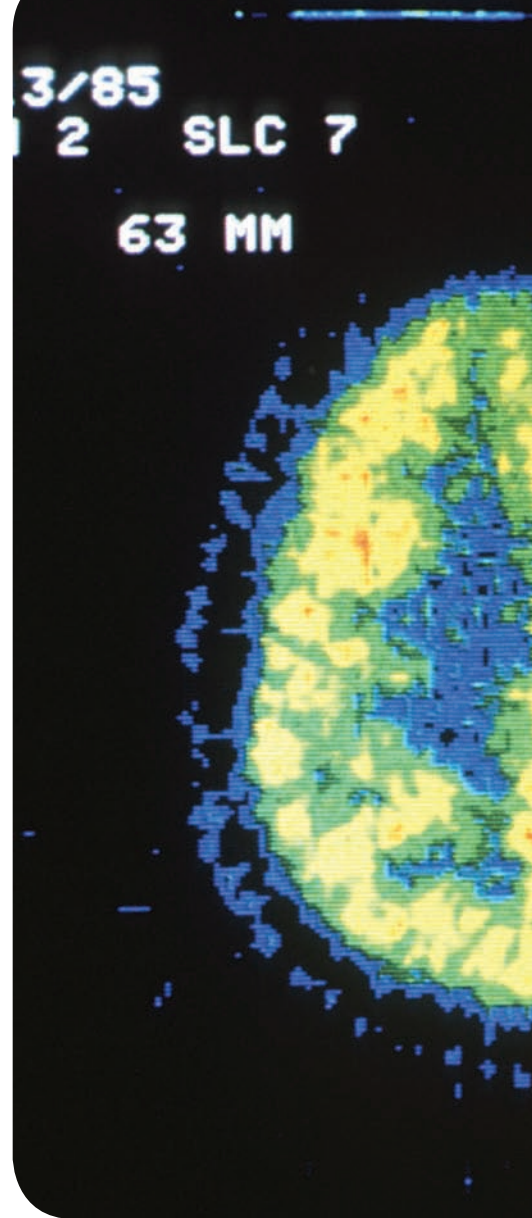
After studying this chapter, you should be able to

- Discuss risk factors for developing a mental disorder
- List the early warning signs and symptoms of a mental disorder
- Discuss the causes of mental disorders
- Describe how mental disorders are diagnosed
- Describe treatment options for mental disorders
- Describe the incidence, signs and symptoms, etiology, diagnosis, treatment, and prevention for the major mental disorders

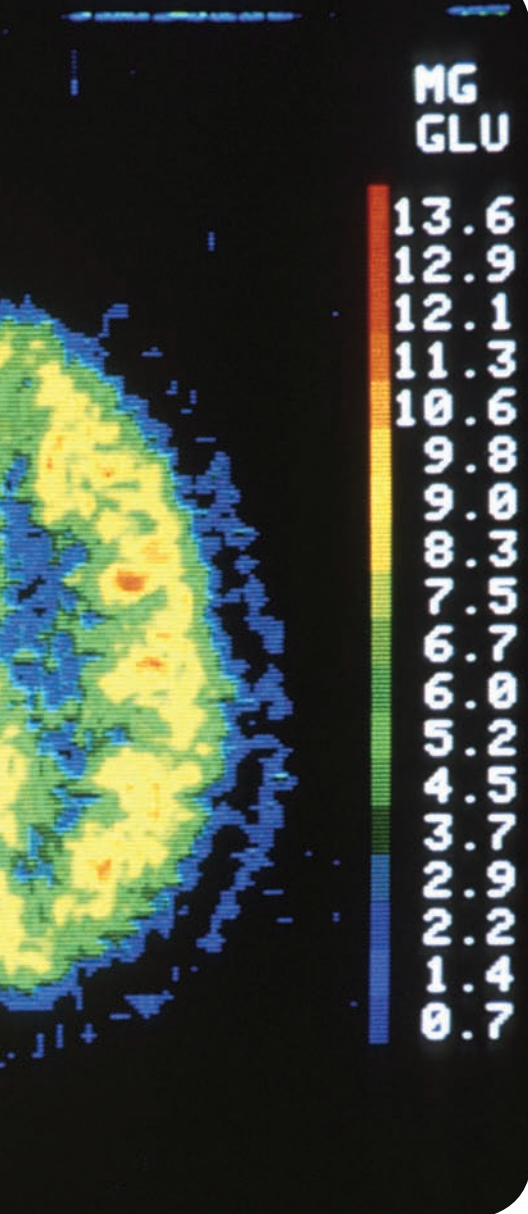
Fact or Fiction?

Depression is the leading cause of disability worldwide.

Fact: The World Health Organization estimates that more than 350 million people of all ages suffer from depression. Depression is the leading cause of disability worldwide, and is a major contributor to the global burden of disease.



PET scan of a normal brain. (Dr. Giovanni Dichiuro, Neuroimaging Section, National Institute of Neurological Disorders and Stroke)



Disease Chronicle

Antidepressants

In 1951 at Sea View Hospital in Staten Island, New York, a clinical trial on a new antituberculosis drug called iproniazid began. It was noted that even terminally ill patients who were given this drug became cheerful, more optimistic, and more physically active. In 1954, several patients given the drug raudixin to control high blood pressure complained of crying spells, lethargy, hopelessness, and suicidal thoughts. How could these simple, seemingly unrelated drugs produce such profound and opposite effects on mood? It was around the same time that scientists were learning about neurotransmitters and the brain. Could iproniazid and raudixin alter the levels of some of the neurotransmitters in the brain? Raudixin drastically lowered while iproniazid increased the concentration of the neurotransmitter serotonin. Swedish researcher Arvid Carlsson created zimelidine, the first drug that specially elevated serotonin concentrations. Pharmaceutical companies followed Carlsson's lead to find serotonin-enhancing drugs and in the 1970s serotonin reuptake inhibitor antidepressants were born. Prescribing antidepressants has risen nearly 400% since 1988 in the United States; more than 1 in 10 Americans over age 12 now takes an antidepressant.

"Happiness depends more on the inward disposition of mind than on outward circumstances."

—Benjamin Franklin

Introduction

Just as good physical health is important, so is good mental health. **Mental health** is the condition of being sound mentally and emotionally that is characterized by the absence of mental disorder and by adequate adjustment, especially as reflected in feeling comfortable about oneself, positive feelings about others, and ability to meet the demands of life.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM), published by the American Psychiatric Association, is used by health care professionals in the United States and much of the world as the authoritative guide to the diagnosis of mental disorders. The fifth edition of the DSM defines mental disorder as a syndrome characterized by clinically significant disturbance in an individual's cognition, emotion regulation, or behavior that reflects a dysfunction in the psychological, biological, or developmental processes underlying mental functioning. Mental disorders are usually associated with significant distress or disability in social, occupational, or other important activities.

Mental disorders are common. An estimated 26.2% of Americans ages 18 and older—about one in four adults—suffer from a diagnosable mental disorder in a given year (Table 15-1 ►). Nearly one in five children in the United States suffers from a mental disorder. Suicide was the 10th leading cause of death in the United States in 2010. According to the World Health Organization, more than 450 million people worldwide suffer from mental disorders. Mental disorders can affect persons of any age, race, religion, or income.

TABLE 15-1 Most Commonly Diagnosed Mental Disorders

1. Mood disorders
2. Personality disorders
3. Eating disorders
4. Attention-deficit/hyperactivity disorder
5. Phobias
6. Anxiety disorders
7. Panic disorders
8. Bipolar disorder
9. Schizophrenia
10. Autism spectrum disorders

Prevention PLUS!

Exercise and Mental Disorders

Exercise may prevent mental disorders by promoting overall physical wellness, which will aid in positive energy levels and clarity of mind. Exercise:

- *Releases endorphins.* Endorphins are chemicals that are released in the brain during exercise or physical activity. They produce feelings of euphoria and satisfaction, which in turn will increase the level of overall happiness.
- *Boosts self-esteem.* Some mental disorders can be derived from not feeling great about yourself physically or emotionally. By exercising, you are constantly pushing yourself to accomplish your daily goals and reaping the benefits of those accomplishments.

Think Critically

1. What chemicals in the brain are released during exercise?
2. How do those chemicals make you feel?
3. Besides releasing chemicals in the brain, name one other way exercise may benefit mental health.

Promote Your Health

Mental Health Tips

Just as in physical health, there are actions you can take to increase your mental health:

1. Develop and maintain strong relationships with people who will support and enrich your life.
2. A diet that is good for your physical health is also good for your mental health.

3. Helping someone can put your problems into perspective and make you feel valued.
4. Set aside time for activities and hobbies you enjoy.
5. Try to manage your stress; consider yoga or meditation.
6. Ask for help.

Risk Factors

A variety of risk factors can impact mental health; being aware of potential risk factors can aid in maintaining good mental health.

Genes may influence the development of some mental disorders; therefore having a parent or sibling with a mental disorder may increase the risk of developing a mental disorder. Environmental factors such as damage from exposure to alcohol, illegal drugs, infection, toxins, brain injury, oxygen deprivation, and poor nutrition may negatively affect the development of the fetus and may contribute to the onset of mental disorders. Children that experience stress from poverty, abuse, and neglect may be vulnerable to developing mental health disorders. Experiencing brain damage as a result of a serious brain injury may increase the risk of developing mental disorders. Traumatic life events such as the death of a parent, war, or a tragic accident can have a traumatic effect on emotional well-being. Chronic or disabling illness can cause isolation and loss of necessary support from family and friends. Alcohol and drug abuse may cause or exacerbate preexisting mental health disorders.

Early Warning Signs and Symptoms of Mental Disorders

Mental disorders rarely come on suddenly. Most often family, friends, teachers, or coworkers—even the individual him- or herself—recognize that something is wrong with the person's thinking, feelings, or behavior. Being familiar with the early warning signs of mental disorders can aid in intervening to possibly delay or prevent the mental disorder. If several of the signs or symptoms in Table 15–2 ► are occurring, a mental disorder may be developing.

Causes of Mental Disorders

Determining the cause of a mental disorder is very challenging. Mental health disorders typically arise from an interaction between biological, psychological, and environmental factors.

Some mental disorders may be passed on from one generation to another through the genes;

TABLE 15–2 Early Warning Signs and Symptoms of Mental Disorders

Withdrawing from friends and family
Dramatic changes in eating or sleeping habits
Deterioration in personal hygiene
Confused thinking
Prolonged sadness
Decreased ability to concentrate
A drop in school or work performance
Decrease in motivation
Irritability
Moodiness
Increased anxiety or agitation
Unusual ideas or beliefs
Mistrustfulness or suspiciousness

therefore a person with a family history of a mental disorder is more vulnerable to develop a mental disorder. It is believed that mental disorders are associated with abnormalities in several genes. This is the reason why the person inherits the vulnerability to develop a mental disorder but does not inherit the mental disorder itself. Brain defects, injury to certain areas of the brain, or trauma to the brain at the time of birth may lead to mental disorders. Disruption of fetal brain development from alcohol or drug use or certain infection may be a factor in the development of mental disorders. An imbalance of neurotransmitters, chemical signals that help brain cells communicate, may be involved in some mental disorders.

Severe psychological trauma may contribute to mental illness. People who have gone through emotional, physical, or sexual abuse, neglect, bullying, or domestic violence may not be able to cope with their traumatic past. Certain environmental stressors such as poverty, living in a difficult and unsafe environment, a dysfunctional family life, death, divorce, low self-esteem, and social or cultural expectations may trigger a mental disorder in a susceptible person.

Diagnosing Mental Disorders

Diagnosing mental disorders begins with a complete medical history. A physical examination and laboratory testing rule out an underlying medical condition as the etiological agent of the signs and symptoms. Laboratory testing may include blood tests, imaging tests, urinalysis, hormone testing, and electroencephalogram to measure and record the electrical activity of the brain. If no organic cause is found the patient is referred to a mental health professional that is specifically trained to diagnose and treat mental disorders.

A comprehensive psychiatric evaluation (CSE) is used in diagnosing mental disorders. Each CSE is different; the most common components of a CSE are discussed here. The mental health professional will interview the patient. The interview will cover a wide range of topics. He or she will then use the DSM to diagnose the mental disorder(s). For each disorder included in DSM, a set of diagnostic criteria indicate what signs and symptoms must be present and for how long. The DSM should only be used by mental health professionals who have received specialized training, including reviewing the signs and symptoms that brought the patient in for evaluation, the patient's past psychiatric history, family history of medical and mental health problems, substance abuse, developmental history, medical history, and mental status.

A mental status examination (MSE) is an assessment tool used by mental health professionals (Table 15–3 ►). MSE data can be obtained informally during the patient interview and from questioning the patient. The MSE provides insight as to what additional assessment is needed. Additional assessment may include personality, reasoning, aptitude, and intelligence quotient testing.

Treating Mental Disorders

During psychotherapy, a person with a mental disorder talks to a licensed and trained mental health care professional. Psychotherapy helps patients understand the behaviors, emotions, and ideas that contribute to their mental disorder. The knowledge and insights gained during psychotherapy help patients manage the signs and symptoms of their mental disorder.

Medications don't cure mental disorders, but they can significantly improve signs and symptoms. Commonly used classes of prescription psychiatric medications include antidepressants, mood stabilizers, anti-anxiety medications, stimulants, and antipsychotics. **Psychosis** is a loss of contact with reality that usually includes **delusions** (false beliefs about what is taking place or who one is) and **hallucinations** (seeing or hearing things that aren't there).

Brain stimulation treatments are generally reserved for situations where medication and psychotherapy have not worked. Brain stimulation therapies involve activating or touching the brain directly with electricity, magnets, or implants, producing changes in the chemistry and functioning of the brain. Hospitalization is recommended when patients can't care for themselves or when they are in immediate danger of harming themselves or someone else.

Specific Mental Disorders

Major Depressive Disorder

People with **major depressive disorder** (MDD) have a constant sense of hopelessness and despair that is disabling and prevents them from functioning normally. Each year about 7% of adults in the United States experience MDD. This disorder is more prevalent in women than in men. While MDD can develop at any age, the median age at onset is 32.

Signs and symptoms of MDD may include feelings of sadness, guilt, worthlessness, and hopelessness; irritability; loss of interest in activities that used to be pleasurable; insomnia or excessive sleep; change in appetite; difficulty concentrating, thinking, or making decisions; and frequent thoughts of death, dying, or suicide. The etiology of MDD is idiopathic; however, genetics, neurotransmitters, and environmental and psychological factors may play a role in its development. Diagnosis of MDD may include a complete medical history, physical examination, laboratory testing, and comprehensive psychiatric evaluation. Treatment may include antidepressant medications, psychotherapy, electroconvulsive therapy, and other brain stimulation therapies. MDD is not preventable.

TABLE 15–3 Mental Status Examination

Domain	Observations/inquiries
Appearance	Observed: How does the patient look? Neatly dressed? Well groomed? Appropriately dressed for the season?
Behavior	Observed: Mannerisms, expression, eye contact
Attitude	Observed: Pleasant, cooperative, agitated, hostile, open, secretive, evasive, suspicious, apathetic, easily distracted, focused, defensive
Level of consciousness	Observed: Is the patient conscious? If not, can he or she be aroused?
Orientation	Inquired: What is your full name? Where are we? What is the month, day, and year?
Speech and language	Observed: Are speech and language normal in tone, volume, and quantity?
Mood	Inquired: How are you feeling? Have you been depressed lately? Have you been angry lately? Have you felt out of control lately?
Affect	Observed: Does the patient make eye contact? Is he or she excitable? Does the tone of his or her voice change?
Thought process	Observed/inquired: Are the patient's responses to general questioning logical, relevant, and organized?
Thought content	Observed/inquired: What has been on your mind lately? Are there thoughts or images you have a really difficult time getting out of your head? Do you have personal beliefs not shared by others? Does it ever seem like people are stealing your thoughts or perhaps inserting thoughts into your head? Does it ever seem like your own thoughts are broadcast out loud?
Suicidality and homicidality	Inquired: Do you ever feel that life isn't worth living? Have you ever thought of doing away with yourself? If so, how? Do you think about hurting others or getting even with people who have wronged you?
Insight and judgment	Observed/inquired: What brings you here today? What do you think is causing your problems? Do you think that these thoughts, moods, or perceptions are abnormal? If you found a stamped, addressed envelope on the street, what would you do with it?
Attention span	Observed/inquired: I will recite a series of numbers to you, and then I will ask you to repeat them to me, first forward and then backward. Starting with 100, subtract 7 from 100, and then keep subtracting 7 from that number as far as you can go.
Memory	Observed/inquired: What time was your appointment with me today? When and where did you get married? I am going to ask you to remember three words and I will ask you to repeat them to me in 5 minutes.
Intellectual functioning	Observed/inquired: Name the current president and vice president. How are an apple and an orange similar? How would you describe the meaning of the saying "two heads are better than one"?

Healthy Aging

Depression

Depression affects more than 6.5 million of the 35 million Americans age 65 years or older. It is a myth that depression is part of the aging process. It is not normal for people of any age to suffer from depression. Many senior citizens think that depression is a character flaw. They may blame themselves for their depression and are too ashamed to get help. Getting help is worthwhile; depression has a high rate of successful treatment.

Personality Disorders

A deeply ingrained, inflexible pattern of relating, perceiving, and thinking that is serious enough to cause distress or impaired functioning describes **personality disorders**. Personality disorders occur in approximately 9% of adults in the United States. Common personality disorders are described below.

- **Antisocial personality disorder**—They repeatedly perform acts that are grounds for arrest. They have no regard for the safety of themselves or others. They lack remorse for their behavior, and they are very irresponsible and deceitful. The estimated prevalence of antisocial personality disorder is 1% in adults in the United States.
- **Avoidant personality disorder**—They are hypersensitive to criticism or rejection. They feel inadequate. They are extremely shy and timid in social situations. They avoid work or social activities that involve socializing or interacting with others. The estimated prevalence is 5% of adults in the United States.
- **Borderline personality disorder**—They have very unstable interpersonal relationships. They are very impulsive. They have an unstable and fluctuating self-image. They experience abrupt, extreme mood changes. They engage in recurrent suicidal behavior. The estimated prevalence of borderline personality disorder is 2% of adults in the United States.
- **Paranoid personality disorder**—They are very distrustful and suspicious of others. They think other people's motives are suspect or evil. They believe people will exploit, harm, or deceive them. Someone with this disorder is difficult to get along with. The estimated prevalence of paranoid personality disorder is 2% of adults in the United States.
- **Schizoid personality disorder**—They are loners who prefer solitary activities. They are often distant, detached, or indifferent to social relationships. The estimated prevalence of schizoid personality is 5% of adults in the United States.
- **Schizotypal personality disorder**—They have difficulty forming and maintaining close relationships. People with this disorder usually have cognitive or perceptual distortions as well as eccentricities in their everyday behavior. The estimated prevalence of schizotypal personality is 5% of adults in the United States.
- **Obsessive-compulsive personality disorder**—They have a preoccupation with orderliness and rules. They always strive for perfection. Their inflexibility often makes them incapable of adapting to change. They are never satisfied with their accomplishments. They weigh all aspects of a problem, often making it difficult for them to make decisions or complete tasks. The estimated prevalence of obsessive-compulsive personality disorder is 1% of adults in the United States.
- **Dependent personality disorder**—They have a pervasive and excessive need to be taken care of. They engage in passive, needy, and clingy behavior. They can't make decisions without the advice of others. They feel uncomfortable and helpless when alone. The estimated prevalence for dependent personality disorder is less than 1% of adults in the United States.
- **Histrionic personality disorder**—They are attention-seekers that always need to be the center of attention and they feel uncomfortable when they are not. They are often thought of as being shallow. They may engage in seductive or provocative behavior to draw attention to themselves. The estimated prevalence of histrionic

personality disorder is 2% of adults in the United States.

- **Narcissistic personality disorder**—They believe they are special and unique. They exaggerate their achievements or talents. They often take advantage of others. Their behavior is arrogant. They lack empathy. The estimated prevalence of narcissistic personality disorder is 1% of adults in the United States.

General signs and symptoms of a personality disorder may include frequent mood swings, volatile relationships, social isolation, suspicion and mistrust of others, difficulty forming close relationships, and impulsivity. The etiology of personality disorders is idiopathic; however, genetics and environmental factors may play a role in the development of personality disorders. Diagnosis may include a complete medical history, physical examination, laboratory testing, and comprehensive psychiatric evaluation. Treatment depends on the particular personality disorder and may include psychotherapy and medications to reduce signs and symptoms (antidepressants, mood stabilizers, anti-anxiety medications, and antipsychotics). Personality disorders are not preventable.

Eating Disorders

Eating disorders are a group of conditions marked by an unhealthy relationship with food. It is estimated that 8 million Americans have an eating disorder: 7 million women and 1 million men. The main types of eating disorders are anorexia nervosa, bulimia nervosa, and binge eating disorder.

- **Anorexia nervosa**—People with anorexia nervosa see themselves as overweight, even when they are clearly underweight. Eating, food, and weight control become obsessions. Signs and symptoms may include extreme thinness, an intense fear of gaining weight, extremely restricted eating, and a distorted body image. An estimated 0.6% of the adult population in the United States suffers from anorexia nervosa. Women are three times more likely to experience anorexia nervosa than men.
- **Bulimia nervosa**—The disorder is characterized by cycles of extreme overeating,

followed by behavior that compensates for the overeating such as vomiting, use of laxatives, fasting, and excessive exercise. The compensatory behavior is done in secret and is often accompanied by feelings of disgust or shame. People with bulimia nervosa usually maintain a normal weight. Signs and symptoms of bulimia nervosa may include damaged teeth and gums, dehydration, intestinal distress and irritation, going to the bathroom after eating or during meals, and sores in the throat and mouth. An estimated 1% of the adult population in the United States suffers from bulimia nervosa. Women are three times more likely to experience bulimia nervosa than men.

- **Binge eating disorder**—This disorder is characterized by regular episodes of extreme overeating without trying to compensate for the behavior. People with binge eating disorder are often overweight or obese. People with binge eating disorder experience guilt, shame, and distress about their binge eating, which can lead to more binge eating. Signs and symptoms may include the disappearance of large amounts of food in a short time, finding lots of empty food wrappers or containers, hoarding food, hiding large quantities of food in strange places, and constantly dieting but rarely losing weight. An estimated 3% of the adult population in the United States suffers from binge eating disorder. Women are 75% more likely to have binge eating disorder than men.

The etiology of eating disorders is idiopathic; however, biological, social, psychological, and interpersonal factors may contribute to the development of eating disorders. Diagnosis may include a complete medical history, physical examination, laboratory testing, and comprehensive psychiatric evaluation. Treatment may include medical care and monitoring, psychotherapy, weight restoration, nutritional counseling, medications (antidepressants, anti-anxiety medications, mood stabilizers), and hospitalization. Eating disorders are not preventable.

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is characterized by a persistent pattern of inattention and/or hyperactivity. ADHD is estimated to occur in 5% of school-age children and 2.5% of adults in the United States. ADHD usually becomes evident in the preschool or early elementary years. The median age of onset of ADHD is 7, although the disorder can persist into adolescence and occasionally into adulthood. Signs and symptoms of ADHD include inattention (has trouble staying focused, has difficulty remembering things and following instructions, makes careless mistakes), hyperactivity (constantly fidgets and squirms, moves around constantly, talks excessively), and impulsivity (frequently interrupts others, acts without thinking, does not wait his or her turn).

The etiology of ADHD is idiopathic. Diagnosis may include a complete medical history, physical examination, laboratory testing, educational testing, and comprehensive psychiatric evaluation. In July 2013 the Food and Drug Administration approved a brain-wave test to help diagnose ADHD. The test uses an electroencephalogram to measure theta and beta brain waves. Certain combinations of these brain waves tend to be more prevalent in children with ADHD.

There is no cure for ADHD. Treatment is most successful when a team approach is used, with teachers, parents, and therapists or physicians working together. Treatment may include stimulant medication that increases the levels of the neurotransmitters dopamine and norepinephrine to help control hyperactivity and impulsive behavior and increase attention span. ADHD patients benefit from special education that includes a structured environment and use of routines. Behavior modification may be used to support healthy behavior and decrease problem behavior. Social skills training and counseling may also benefit the patient with ADHD. Parenting skills training and family psychotherapy may also be part of treatment. ADHD is not preventable.

Anxiety Disorders

Many people feel anxious, or nervous, when faced with a problem at work, before taking a

test, or making an important decision. For some people, however, anxiety can become excessive. **Anxiety disorders** are characterized by excessive fear and anxiety. Anxiety disorders are the most common class of mental disorders present in the population. The estimated prevalence of anxiety disorders is 18% of adults in the United States. Most people with an anxiety disorder will have their first episode by age 21. Recognized types of anxiety disorders include those described below.

- **Panic disorder**—Characterized by recurring, severe panic attacks that strike suddenly and repeatedly with no warning. Signs and symptoms of a panic attack may include sweating, chest pain, trembling, nausea, lightheadedness, chills or hot flashes, and shortness of breath. The estimated prevalence of panic disorder is 3% of adults in the United States. The median age of onset is 24.
- **Obsessive-compulsive disorder (OCD)**—People with OCD are plagued by constant disturbing thoughts or fears that cause them to perform certain rituals or routines. The estimated prevalence of OCD is 1% of adults in the United States. The first symptoms of OCD often begin during childhood or adolescence; however, the median age of onset is 19.
- **Posttraumatic stress disorder (PTSD)**—Develops after a traumatic or terrifying event. Signs and symptoms may include flashbacks, nightmares, and severe anxiety, as well as uncontrolled thoughts about the event. The estimated prevalence of PTSD is 4% of adults in the United States. PTSD can develop at any age but the median age of onset is 23.
- **Social anxiety disorder**—An excessive and unreasonable fear of social situations. The anxiety is a result of fear of being watched, judged, and criticized by others. The estimated prevalence of social anxiety disorder is 7% of adults in the United States. Social phobia begins in childhood or adolescence, typically around age 13.
- **Specific phobia**—A persistent, irrational fear of a specific object, activity, or situation that leads to a compelling desire to avoid it. The estimated prevalence of specific phobia

is 9% of adults in the United States. Specific phobia usually begins in childhood; the median age of onset is 7.

- **Generalized anxiety disorder**—Long-lasting anxiety that is not focused on any one object or situation. The estimated prevalence of generalized anxiety disorder is 3% of adults in the United States. The median age of onset is 31.
- **Agoraphobia**—An intense fear and anxiety of any place or situation where escape might be difficult, leading to avoidance of situations such as being alone outside of the home; traveling in a car, bus, or airplane; or being in a crowded area. The estimated prevalence of agoraphobia is 0.8% of adults in the United States. The median age of onset is 20.

Signs and symptoms vary depending on the type of anxiety disorder, but general signs and symptoms include overwhelming feelings of panic and fear, uncontrolled obsessive thoughts, painful and intrusive memories, recurring nightmares, and physical signs and symptoms (such as nausea, heart palpitations, muscle tension). The etiology of anxiety disorders is idiopathic; however, genetics and environmental, psychological, and developmental factors may play a role in their development.

Diagnosis may include a complete medical history, physical examination, laboratory testing, and comprehensive psychiatric evaluation. Treatment may include anti-anxiety medications, which depress the central nervous system and slow normal brain function, and psychotherapy. Anxiety disorders are not preventable.

Bipolar Disorder

Bipolar disorder causes unusual shifts in mood, energy, activity levels, and the ability to carry out day-to-day tasks. Mood shifts between mania and depression may occur only a few times a year, or as often as several times a day. The prevalence of bipolar disorder is 2.6% of adults in the United States. The median age of onset for bipolar disorder is 25.

The signs and symptoms of bipolar disorder vary from person to person. Signs and

symptoms of the manic phase of bipolar disorder may include euphoria, increased energy and activity, rapid speech, racing thoughts, inflated self-esteem, impulsive behavior, being easily distracted, and a decreased need for sleep. Signs and symptoms of the depressive phase of bipolar disorder may include sadness, hopelessness, loss of interest in activities once considered enjoyable, problems concentrating, change in eating or sleeping pattern, and suicidal thoughts or behavior. The etiology of bipolar disorder is idiopathic, but genetics, environmental factors, and neurotransmitters may play a role in the development of bipolar disorder.

Diagnosis may include a complete medical history, physical examination, laboratory testing, and comprehensive psychiatric evaluation. Bipolar disorder requires lifelong, continuous treatment to control signs and symptoms. Treatment may include mood-stabilizing and antidepressant medications and psychotherapy. Antidepressants increase the availability of neurotransmitters. The mechanism of mood-stabilizing medications is unclear. Bipolar disorder is not preventable.

Schizophrenia

Schizophrenia distorts the way a person thinks, acts, expresses emotions, perceives reality, and relates to others. The estimated prevalence of schizophrenia is 1.1% of the adult population in the United States. Schizophrenia affects men and women equally. Schizophrenia often first appears in men in their late teens or early 20s. In contrast, women are generally affected in their 20s or early 30s.

Signs and symptoms of schizophrenia may include hallucinations, delusions, disordered speech and behavior, lack of motivation and emotional expression, problems making sense of information, difficulty paying attention, social withdrawal, poor personal hygiene, and memory problems. The etiology of schizophrenia is idiopathic; however, a combination of genetics and the environment is thought to contribute to the development of schizophrenia.

Schizophrenia diagnosis may include a complete medical history, physical examination, laboratory testing, family interviews,

and a comprehensive psychiatric evaluation. Antipsychotic medications are the cornerstone of schizophrenia treatment. Antipsychotic medications mainly block the receptors for the neurotransmitter dopamine in the brain and help reduce the signs and symptoms of schizophrenia. Other treatments may include social skill and vocational training and family and individual psychotherapy. Schizophrenia is not preventable.

Autism Spectrum Disorders

Autism spectrum disorders (ASD) are a range of complex developmental disorders that can cause problems with thinking, feeling, language, and the ability to relate to others. ASD is usually first diagnosed in childhood and is five times more common in boys than in girls. In 2014, the Autism and Developmental Disabilities Monitoring Network of the Centers for Disease Control estimates that 1 in 68 children are identified with ASD. This estimate is approximately 30% higher than the estimate for 2008 (1 in 88), 60% higher than the estimate for 2006 (1 in 110), and 120% higher than the estimate for 2002 and 2000 (1 in 150). Boys are almost 5 times more likely to be identified with ASD than girls. ASD is usually not diagnosed until after age 4 but it can be diagnosed as early as age 2.

Signs and symptoms can range from mild to severe and often change over time. There is a great range of abilities and characteristics of children with ASD. Many children with ASD have normal cognitive skills, whereas others have cognitive challenges. ASD patients have communication problems (difficulty using or understanding language), difficulty relating to people (trouble making friends and interacting with people, difficulty reading facial expressions, difficulty making eye contact), and repetitive body movements or behaviors (hand flapping or repeating sounds or phrases).

The etiology of ASD is idiopathic. Early diagnosis and treatment are important to reducing the signs and symptoms of ASD and improving the quality of life for people with ASD and their families. Diagnosis includes screening for developmental milestones from birth to at least 36 months of age. When a developmental milestone screening or a parent raises concerns

about a child's development, a referral to a mental health professional is appropriate. The mental health professional will perform a comprehensive diagnostic evaluation that may include a complete medical history, hearing and vision screenings, genetic testing, neurological testing, and comprehensive psychiatric evaluation.

ASD requires long-term treatment that includes different treatments at different times. Effective treatment for ASD may involve a number of professionals including psychiatrists, pediatricians, pediatric neurologists, psychologists, special educators, speech and language therapists, and social workers. There is significant controversy over what forms of therapy are best for patients with ASD. Treatment may include changes in the child's academic program; speech, occupational, and physical therapy; behavioral programs to improve social and communication difficulties; and pharmacological intervention for other mental disorders. ASD cannot be prevented.

Intellectual Disability

People with intellectual disability (ID) experience significant limitations in two main areas: intellectual functioning and **adaptive behavior** (the use of everyday social and practical skills). ID has its onset during the developmental period. The prevalence of ID is estimated to be 1–3% of the United States population. The presenting signs and symptoms of ID typically include delays in cognitive skills, language, and adaptive skills. ID may be caused by genetic conditions (e.g., trisomy 21, fragile X syndrome, phenylketonuria), problems during pregnancy (maternal alcohol or drug use, certain infections, malnutrition), problems at birth (oxygen deprivation, premature birth, low birth weight), certain infections during childhood (measles, meningitis, whooping cough), injury during childhood (severe head injury, near drowning, extreme malnutrition, lead poisoning), or unknown causes.

Diagnosis may include a complete history, physical examination, genetic testing, imaging studies, metabolic screening, and a comprehensive psychiatric evaluation. Treatment may include treating the underlying cause of ID, therapy (speech, occupational, physical), and family psychotherapy. Not all types of ID can be

Promote Your Mental Health

Social Support

One of the most important ways to prevent mental disorders is to maintain strong ties with family, friends, and coworkers. The prognosis for people with a mental disorder is much

worse for people who are socially isolated. Friends and family provide support, help with treatment, and alleviate the sense of isolation.

prevented; however, prevention of ID includes genetic screening of newborns, removal of lead from the household environment, use of child safety seats and bicycle helmets, comprehensive prenatal care, not drinking alcohol or using drugs while pregnant, and vaccination.

Age-Related Disorders

People age 65 and older are the fastest-growing segment of the population in the United States. It is estimated that the number of older adults with mental and behavioral health problems will almost quadruple, from 4 million in 1970 to 15 million in 2030. Approximately 20% of adults age 55 and over suffer from a mental disorder, the most common being anxiety disorders (e.g., generalized anxiety and panic disorders), severe cognitive impairment (e.g., Alzheimer's disease), and mood disorders (e.g., depression and bipolar disorder). Some late-life problems that may play a role in the development of a mental disorder include coping with physical health problems, caring for a spouse with dementia or a physical disability, grieving the death of loved ones, and managing conflict with family members. Unfortunately, many older people still believe that

mental health disorders result from personal failure or weakness. This stigma means that they may not want to admit that a mental disorder exists and do not seek help. Older adults have the highest suicide rate in the country. Those age 85 and over have the highest suicide rate; those age 75–84 have the second highest.

Resources

- American Academy of Pediatrics: www.aap.org
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)*. Arlington, VA: American Psychiatric Association, 2013.
- American Psychiatric Association: www.psychiatry.org
- Becker A, Kleinman A. Mental Health and the Global Agenda. *New England Journal of Medicine* 2013;369:66–73.
- Centers for Disease Control and Prevention: www.cdc.gov
- National Alliance on Mental Illness: www.nami.org
- National Institute of Mental Health. *The Numbers Count: Mental Disorders in America*. n.d. www.nimh.nih.gov/health/publications/the-numbers-count-mental-disorders-in-america/index.shtml
- National Institutes of Mental Health: www.nimh.org
- World Health Organization. *Mental Health: Strengthening Our Response*. WHO Fact Sheet No. 220, September 2010.
- World Health Organization: www.who.org

Diseases at a Glance

Mental Disorders

Disorder	Etiology	Signs and Symptoms
Major depressive disorder	Unknown	Feelings of sadness, guilt, worthlessness, and helplessness; irritability; loss of interest in activities that used to be pleasurable; insomnia or excessive sleep; change in appetite; difficulty concentrating, thinking, or making decisions; frequent thoughts of death, dying, or suicide
Personality disorders	Unknown	Frequent mood swings, volatile relationships, social isolation, suspicion and mistrust of others, difficulty forming close relationships, impulsivity
Eating disorders	Unknown	Anorexia nervosa—Extreme thinness, an intense fear of gaining weight, extremely restricted eating, distorted body image Bulimia nervosa—Damaged teeth and gums, dehydration, intestinal distress and irritation, going to the bathroom after eating or during meals, sores in the throat and mouth Binge eating disorder—Disappearance of large amounts of food in a short time or finding lots of empty food wrappers or containers, hoarding food, hiding large quantities of food in strange places, constantly dieting but rarely losing weight
Attention-deficit/hyperactivity disorder	Unknown	Inattention, hyperactivity, impulsivity
Anxiety disorders	Unknown	Vary depending on the type of anxiety disorder but general signs and symptoms include overwhelming feelings of panic and fear, uncontrolled obsessive thoughts, painful and intrusive memories, recurring nightmares, physical signs and symptoms (such as nausea, heart palpitations, muscle tension)
Bipolar disorder	Unknown	Manic phase—euphoria, increased energy and activity, rapid speech, racing thoughts, inflated self-esteem, impulsive behavior, being easily distracted, decreased need for sleep Depressive phase—sadness, hopelessness, loss of interest in activities once considered enjoyable, problems concentrating, change in eating or sleeping pattern, suicidal thoughts or behavior

Diagnosis	Treatment	Prevention
Complete medical history, physical examination, laboratory testing, comprehensive psychiatric evaluation	Antidepressant medications, psychotherapy, electroconvulsive therapy, other brain-stimulation therapies	Not preventable
Complete medical history, physical examination, laboratory testing, comprehensive psychiatric evaluation	Psychotherapy, medications	Not preventable
Complete medical history, physical examination, laboratory testing, comprehensive psychiatric evaluation	Medical care and monitoring, psychotherapy, weight restoration, nutritional counseling, medications, hospitalization	Not preventable
Complete medical history, physical examination, interviews, questionnaires, observations, psychological and educational testing, brain-wave test	Stimulant medication; special, behavior, and social skills training; counseling; parenting skills training; family psychotherapy	Not preventable
Complete medical history, physical examination, laboratory testing, comprehensive psychiatric evaluation	Anti-anxiety medications, psychotherapy	Not preventable
Complete medical history, physical examination, laboratory testing, comprehensive psychiatric evaluation	Mood-stabilizing and antidepressant medications, psychotherapy	Not preventable

Disorder	Etiology	Signs and Symptoms
Schizophrenia	Unknown	Hallucinations, delusions, disordered speech and behavior, lack of motivation and emotional expression, problems making sense of information, difficulty paying attention, social withdrawal, poor personal hygiene, memory problems
Autism spectrum disorders	Unknown	Communication problems, difficulty relating to people, repetitive body movements or behaviors
Intellectual disability disorder	Genetic conditions, problems during pregnancy, problems at birth, certain infections during childhood, injury during childhood, unknown causes	Delays in cognitive, language, and adaptive skills
Alzheimer's disease	Unknown	<p>Early AD—memory problems, visual and spatial issues, impaired reasoning and judgment</p> <p>Mild AD—patient may get lost, have trouble handling money and paying bills, repeat questions, take longer to complete normal daily tasks, use poor judgment, mood and personality changes</p> <p>Moderate AD—memory loss and confusion grow worse; problems recognizing family and friends; unable to learn new things, carry out tasks that involve multiple steps, and cope with new situations; hallucinations; delusions; paranoia; behave impulsively</p> <p>Severe AD—cannot communicate and are completely dependent on others for care</p>

Diagnosis	Treatment	Prevention
Complete medical history, physical examination, laboratory testing, family interviews, comprehensive psychiatric evaluation	Antipsychotic medication, social skill and vocational training, family and individual psychotherapy	Not preventable
Screening for developmental milestones from birth to at least 36 months of age, a complete medical history, hearing and vision screenings, genetic testing, neurological testing, comprehensive psychiatric evaluation	Changes in the child's academic program; speech, occupational, and physical therapy, behavioral programs to improve social and communication difficulties, pharmacological intervention	Not preventable
Complete history, physical examination, genetic testing, imaging studies, metabolic screening, detailed mental assessment	Treating the underlying cause of IDD, therapy (speech, occupational, physical), family counseling	Not all types of IDD can be prevented but may include genetic screening of newborns, removal of lead from the household environment, use of child safety seats and bicycle helmets, comprehensive prenatal care, not drinking alcohol or using drugs while pregnant, vaccination
Can be definitively diagnosed only after death by linking clinical measures with an examination of brain tissue and pathology in an autopsy. A thorough medical history, physical and neurological examination, blood tests, brain imaging, and memory assessment are used to help distinguish AD from other causes of memory loss	Medication can slow the progression of the disease	Not preventable

Interactive Exercises

Cases for Critical Thinking

1. Justine is a 45-year-old woman. Her boss insisted she go see a therapist after she received numerous complaints from Justine's colleagues who find it very difficult to work with her. Justine tells the therapist that her colleagues are just jealous of her and her abilities and that she is the best employee the company has ever had. She also states that no coworker has a skill set that is even remotely close to hers. Justine tells the therapist she can complete a hundred times the work as anyone else in an 8-hour day. She also tells the therapist that her coworkers are just lazy and stupid and they should stop complaining and realize how lucky they are to work with someone so brilliant and amazing. What personality disorder might Justine be suffering from?
2. Deacon is in first grade. His teacher, Mrs. Russ, has noticed some persistent problematic behavior in Deacon. Mrs. Russ has noticed that he constantly squirms and fidgets in his seat. He has difficulty focusing on what they are doing in class. He almost never finishes any assignment or project he starts. Deacon never waits to be called on; instead, he just shouts out answers in class. What mental disorder do you think Mrs. Russ wants to discuss with Deacon's mom?
3. Sheila is a college freshman at a major university in New York. During the first week of school she went to a fraternity party with her roommates. She got tired and decided to leave the party early. Her roommates did not want to leave the party so Sheila decided to walk back to their apartment alone. One her way back to the apartment she was violently assaulted by someone. She lay in an alley for hours, unconscious. Her roommates finally heard her moaning 3 hours later on their way back from the party. They called 911, and Sheila was rushed to the hospital. Sheila sustained several broken bones, a broken jaw, and had been sexually assaulted. She was in the hospital for a few days. When she got out of the hospital she told everyone she was fine. She did not want to talk about the assault, she just wanted to go to school and not think about it. Sheila's roommates have noticed that she rarely attends class. Sheila often screams in the middle of the night. Finally, Sheila's roommates take her to the university health center. After a thorough physical exam she is referred to a mental health professional. What mental disorder is Sheila probably suffering from?

Multiple Choice

- The most commonly diagnosed mental disorder is _____.
 - mood disorders
 - personality disorders
 - eating disorders
 - ADHD
- The handbook used by health care professionals in the United States and much of the world as the authoritative guide to the diagnosis of mental disorders is _____.
 - PDR
 - AMA
 - DSM
 - Axis
- Which of the following is *not* a sign or symptom of attention-deficit/hyperactivity disorder?
 - delusions
 - inattention
 - impulsivity
 - hyperactivity
- Mental health disorders typically arise from an interaction between all of the following *except* _____.
 - environmental factors
 - biological factors
 - physical factors
 - psychological factors
- Potential risk factors for developing a mental disorder include all the following *except* _____.
 - genes
 - chronic illness
 - personal weakness
 - serious brain injury
- Which of the following is *not* included in a mental status examination?
 - movement
 - mood
 - behavior
 - affect
- Binge eating followed by purging behavior such as self-induced vomiting most commonly occurs in _____.
 - anorexia nervosa
 - bulimia nervosa
 - binge eating disorder
 - all of the above
- Which of the following is *not* an early warning sign or symptom of mental disorders?
 - prolonged sadness
 - unusual ideas or beliefs
 - moodiness
 - having an active social life
- People with _____ have a constant sense of hopelessness and despair that is disabling and prevents them from functioning normally
 - agoraphobia
 - generalized anxiety disorder
 - bipolar disorder
 - major depressive disorder
- People with this personality are very distrustful and suspicious of others and think other people's motives are suspect or evil.
 - paranoid
 - schizoid
 - dependent
 - histrionic

True or False

- _____ 1. Mental disorders can affect persons of any age, race, religion, or income.
- _____ 2. Depression is part of the aging process.
- _____ 3. Medications cure mental disorders.
- _____ 4. Nearly one in five children in the United States suffers from a mental disorder.
- _____ 5. People with bulimia nervosa usually maintain a normal weight.
- _____ 6. Severe psychological trauma may contribute to mental illness.
- _____ 7. Autism spectrum disorders are five times more common in boys than in girls.
- _____ 8. Major depressive disorder is more prevalent in men than in women.
- _____ 9. The etiology of all mental disorders is known.
- _____ 10. An estimated one in four adults in the United States suffers from a diagnosable mental disorder in a given year.

Fill-Ins

1. _____ are characterized by excessive fear and anxiety.
2. _____ is a loss of contact with reality.
3. _____ is the condition of being sound mentally and emotionally that is characterized by the absence of mental disorder and by adequate adjustment, especially as reflected in feeling comfortable about oneself, positive feelings about others, and ability to meet the demands of life.
4. _____ is seeing or hearing things that aren't there.
5. An imbalance of _____, chemical signals that help brain cells communicate, may be involved in some mental disorders
6. _____ is characterized by cycles of extreme overeating, followed by behavior that compensates for the overeating such as vomiting, use of laxatives, fasting, and excessive exercise.
7. _____ are false beliefs about what is taking place or who one is.
8. _____ distorts the way a person thinks, acts, expresses emotions, perceives reality, and relates to others.
9. A _____ is an assessment tool used by mental health professionals to evaluate a patient's mental status.
10. During _____, a person with a mental disorder talks to a licensed and trained mental health care professional.

Chapter 16

Diseases and Disorders of the Musculoskeletal System

Learning Objectives

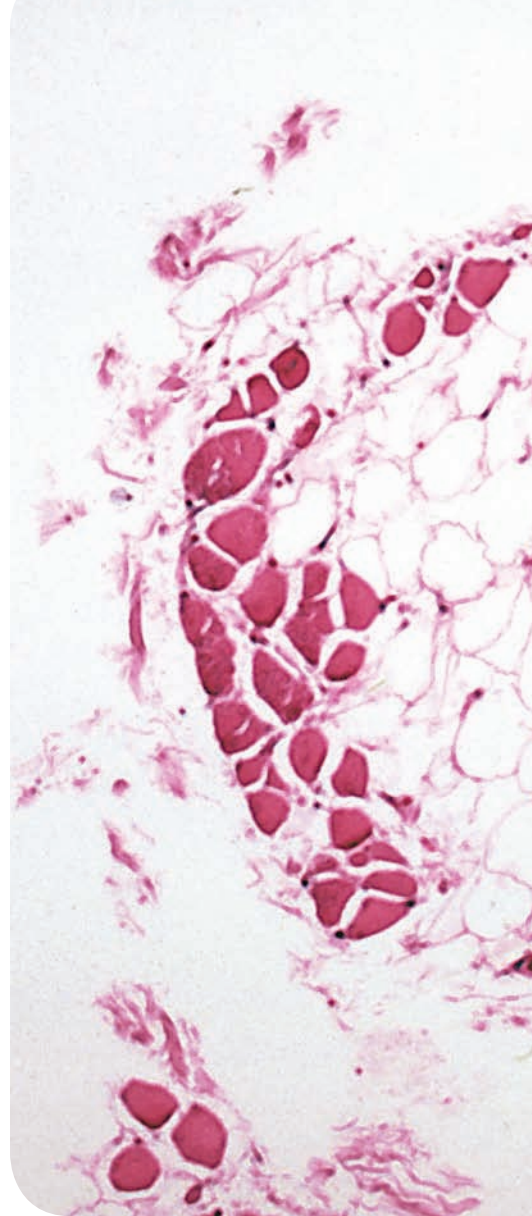
After studying this chapter, you should be able to

- Understand the normal structure and function of bones, joints, and muscle
- Describe the etiology, signs and symptoms, diagnostic tests, and treatment of infectious diseases of bone
- Explain how vitamin and mineral deficiencies lead to bone disease
- Describe the etiology, signs and symptoms, diagnostic tests, and treatment of bone diseases and fractures
- Describe the etiology, signs and symptoms, diagnostic tests, and treatment of the common types of arthritis, gout, and bursitis
- Identify the etiology, signs and symptoms, diagnostic tests, and treatment of herniated discs, dislocations, sprains, strains, and carpal tunnel syndrome
- Describe the etiology, signs and symptoms, diagnostic tests, and treatment of muscular dystrophy and myasthenia gravis
- Understand age-related changes and diseases of the musculoskeletal system

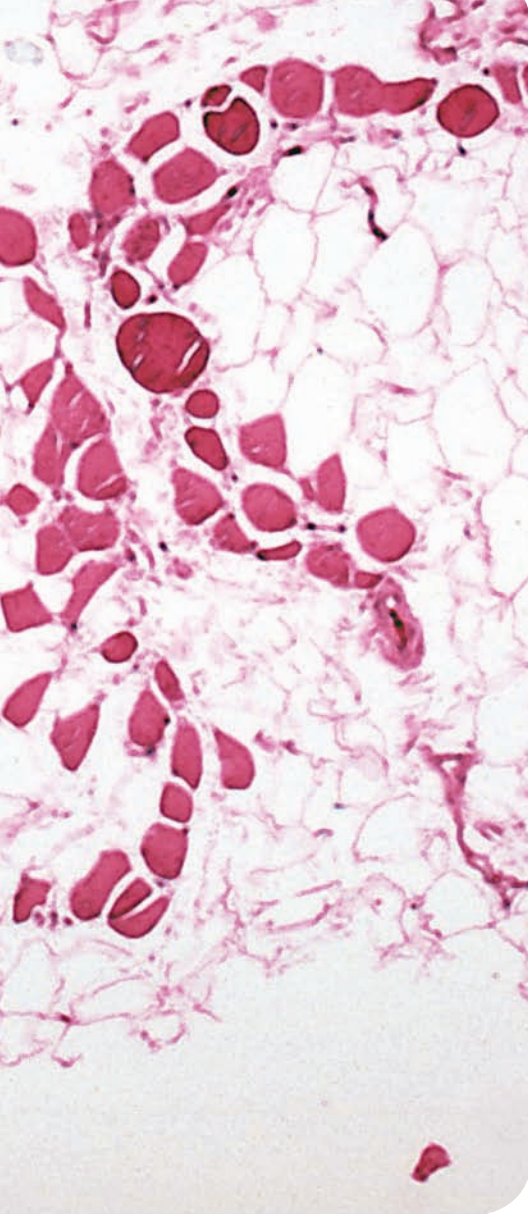
Fact or Fiction?

Rest is the best treatment for arthritis.

Fiction: Unless pain is too severe, daily low-impact exercise maintains mobility and range of motion.



Duchenne's muscular dystrophy. Cross section of gastrocnemius muscle shows extensive replacement of muscle fibers by adipose cells. (Courtesy of the Centers for Disease Control and Prevention/ Dr. Edwin P. Ewing, Jr., 1972)



Disease Chronicle

Arthritis

Arthritis in its various forms has long plagued humans. The lack of medical science, coupled with a desperate search for relief, produced unusual prescriptions in American traditional and folk medicine. One folk healer recommended treating gout by cutting a hole in a tree, holding the affected body part to it, and then sealing the hole with sand to trap the disease. Another 19th-century prescription required the sufferer to carry a potato in the hip pocket. Treating “like with like” was the basis for treating gout with an earthworm, whose curled shape resembles gnarled gout-afflicted appendages. How the earthworm was administered is not clear. A home remedy from Texas called for ingestion of wintergreen oil. These ineffective treatments were benign compared to others. Citing bad blood as the cause, some people were subjected to regular bleedings. Cashing in on the public’s misunderstanding of uranium’s powers in the 1950s, predatory entrepreneurs recommended baths in uranium pools or ingestion of uranium-laced water. Our understanding and treatment of arthritis has progressed significantly. Still, unscrupulous individuals and companies espouse ineffective and expensive treatments that prey upon vulnerable people.

Anatomy and Physiology Review

Bones, joints, and muscles work together intimately. The bones of the skeleton provide the body with a sturdy framework and protect internal organs and the central nervous system. Bones are held together at joints, some of which permit movement of the skeletal framework. Skeletal muscles attach to the bones via tendons. When muscle tissues contract, they shorten and move the skeleton at joints. Thus, the muscles that span a joint bring about action at that joint. Groups of muscles may have opposite or antagonistic actions on a joint. For example, one group of muscles extends (straightens) the knee, while another group flexes (bends) the knee. Still other muscles stabilize joints, preventing undesired movements.

Bone tissue may appear inert, but changes constantly occur within it. Bone development, growth, and homeostasis rely on interplay among its constituent minerals, proteins, and living cells. **Calcium** and **phosphate**, bone's primary minerals, are embedded in **collagen**, bone's main protein. The minerals confer hardness and rigidity to bone, while the collagen imparts flexibility. Mature bone cells, **osteocytes**, along with bone-forming cells, **osteoblasts**, and bone-resorbing cells, **osteoclasts**, reside within this bony matrix. The cells receive nutrients by an organized system of blood vessels that course throughout the bone.

Bones are long, flat, or irregularly shaped, and most are covered with a layer of bone tissue called **compact bone**. The cells, minerals, proteins, and blood vessels of compact bone are arranged in a regular, organized fashion. Another type of bone tissue, **spongy bone**, contains many bone marrow-filled spaces. This red-colored marrow is found at the ends of long bones and is the site of blood cell formation.

The long bones found in the arms and legs contain a hollow cavity, the **medullary cavity**, filled with yellow bone marrow primarily consisting of fat. The growth of long bones occurs at the growth plate, an area of cartilage near each expanded end of the bone (Figure 16-1 ►). At this site, new bone is formed, pushing the ends apart from each other until full growth is achieved, at which time the cartilage turns into bone, a process called **ossification**. Damage to the

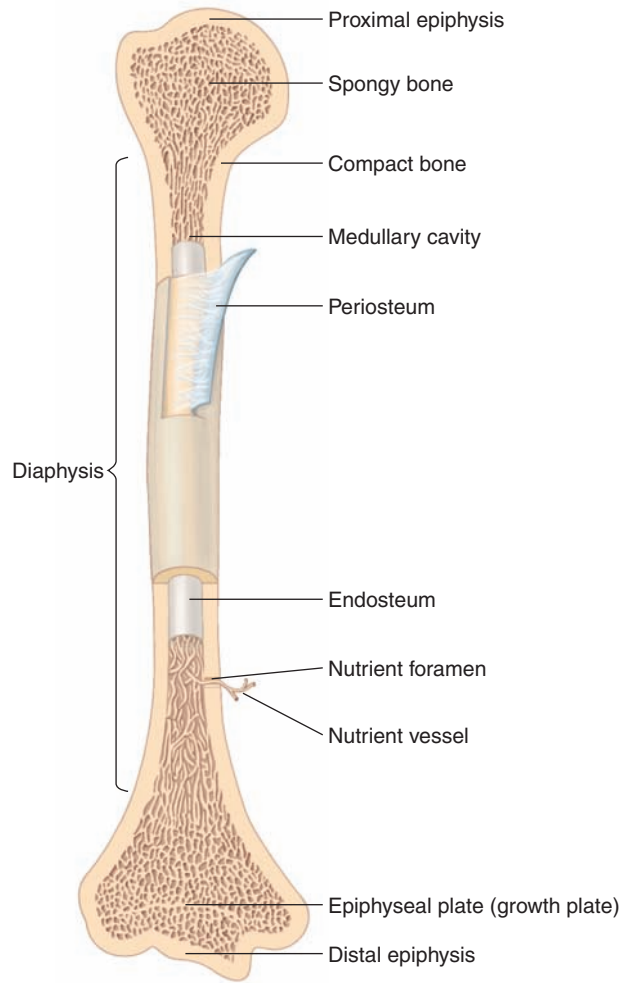


Figure 16-1 ► Cut view of long bone.

growth plate before maturity tends to prevent the bone from reaching its mature length.

The **periosteum** is a highly vascular layer of fibrous connective tissue that covers the surface of bones. It contains cells that are capable of forming new bone tissue and serves as a site of attachment for tendons.

Joints are the articulating sites between bones. A degree of movement, a joint's range of motion, is characteristic of each type of joint. The amount and type of movement at a joint is defined by the shapes of bones and the type of connective tissue holding the bones together at the joint. The shoulder (joint between humerus and scapula) is the most freely movable joint, but it is also the one most easily dislocated.

Several tissues comprise a joint between bones. For joints that freely move, articulating bones are held together by **ligaments**. Dense strands of collagen impart great strength to ligaments. A joint capsule consisting of ligaments and connective tissue surrounds the bone ends. The inner surface of the capsule is lined with a **synovial membrane** that secretes **synovial fluid**, which lubricates the joints. Sacs of synovial fluid, the **bursae**, are situated near some joints, such as the shoulder and knee, where they reduce friction during movement. The articulating surfaces of the bone ends are covered with a layer of cartilage, which also reduces friction. A typical joint is illustrated in Figure 16-2 ►.

Skeletal or **voluntary muscle** tissue is found in muscles that are firmly attached to bones by **tendons**. Some voluntary muscles (e.g., the muscles of facial expression) are attached to soft tissue. Muscles consist of bundles of muscle fibers (muscle cells) held together by connective tissue. When stimulated by nerves at the myoneural junction, muscle fibers contract, and because muscles are attached to bones, the shortening of the muscles moves the bones.

The diseases of muscle described in this chapter are diseases of voluntary muscle. Because muscle action requires nerve stimulation, some

nervous system diseases are manifested in muscles. Those diseases are discussed elsewhere with discussions of the nervous system. This chapter discusses a few muscle diseases that are not directly caused by nervous system disease. Smooth muscle, or involuntary muscle, is a different type of muscle found in the walls of the internal organs and the walls of blood vessels. Cardiac muscle is an involuntary striated muscle and is present only in the heart. This chapter does not address cardiac or smooth muscle disease.

Diagnostic Tests and Procedures

Many musculoskeletal diagnoses require imaging to visualize the tissues. X-rays and computed tomography (CT) reveal fractures, joint dislocations, bone deformities, and calcification. Magnetic resonance imaging (MRI) uses strong magnetic fields to visualize joints, bones, and soft tissues. Arthroscopy is used to visualize the inside of a joint cavity such as the knee. Joint fluid can be aspirated for microscopic and chemical analysis. Electromyography measures electrical activity of muscles and reveals some abnormalities of muscle function. Biopsy can show muscle or bone tissue abnormalities.

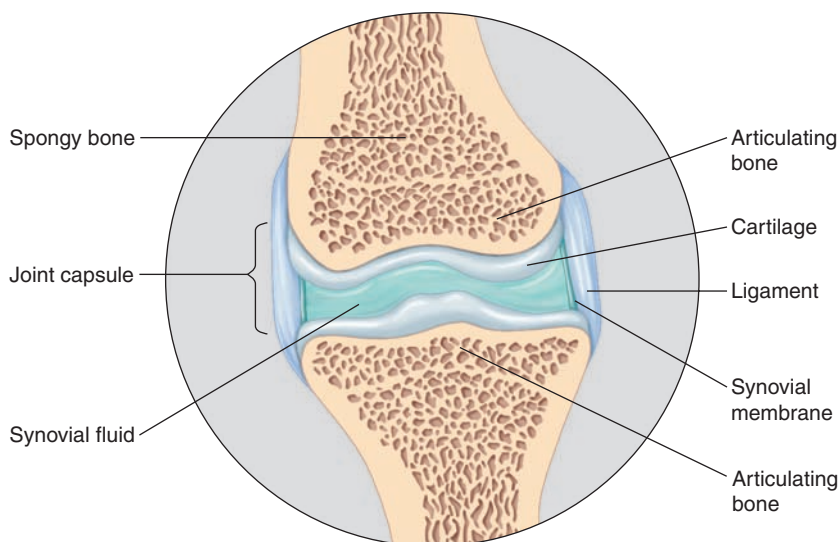


Figure 16-2 ► Typical joint.

Diseases of Bone

Infectious Diseases of Bone

Osteomyelitis is an uncommon bacterial infection of the bone. Osteomyelitis occurs principally following bone trauma or in diabetics.

Signs and symptoms of bone infection include pain, redness, heat, chills, fever, and leukocytosis. Diagnosis begins with history and physical exam and can be confirmed with bone biopsy, white blood cell count, magnetic resonance imaging, and CT. An x-ray will not reveal early infections.

Treatment includes antibiotics, and surgery may be required to remove necrotic bone tissue (Figure 16-3 ►). The best way to prevent osteomyelitis is to treat infections and compound fractures promptly.

Tuberculosis of bone is rare and is associated with untreated pulmonary tuberculosis. This infection occurs when bacteria spread from the lungs to the bones. Affected bones include the ends of long bones and the vertebrae. The infection can be treated with antibiotics, although strains of *Mycobacterium tuberculosis* have developed multiple-drug resistance. Surgery may be able to correct bone deformities. Treatment of pulmonary tuberculosis can help prevent tuberculosis of the bone.

Bone Disease Associated with Vitamin and Mineral Deficiencies

Vitamins and minerals are key to bone health. Calcium and phosphorus are required for proper

bone formation and maintenance. However, dietary calcium cannot be absorbed from the digestive tract without vitamin D. Thus, mineral or vitamin D deficiencies can result in soft, malformed, or fragile bones.

Osteoporosis is a disease characterized by porous bone that is abnormally fragile and susceptible to fracture. Eighty percent of those affected by osteoporosis are women. While some bone loss is expected with aging, the cause of the accelerated bone loss observed in osteoporosis is unknown. However, risk factors for osteoporosis have been identified, and these include being female, Caucasian or Asian, advanced age, and having a small frame (Box 16-1 ►). Osteoporosis affects 20% of all Caucasian women over age 50, and more than half of Caucasian women over age 50 have low bone density, which elevates their risk for developing osteoporosis.

BOX 16-1 Risk Factors for Osteoporosis

Low bone mass	Cigarette smoking
Low calcium intake	Postmenopausal
Female	Excessive alcohol use
Vitamin D deficiency	Hysterectomy
Small frame	Caucasian or Asian
Sedentary lifestyle	Amenorrhea
Family history	

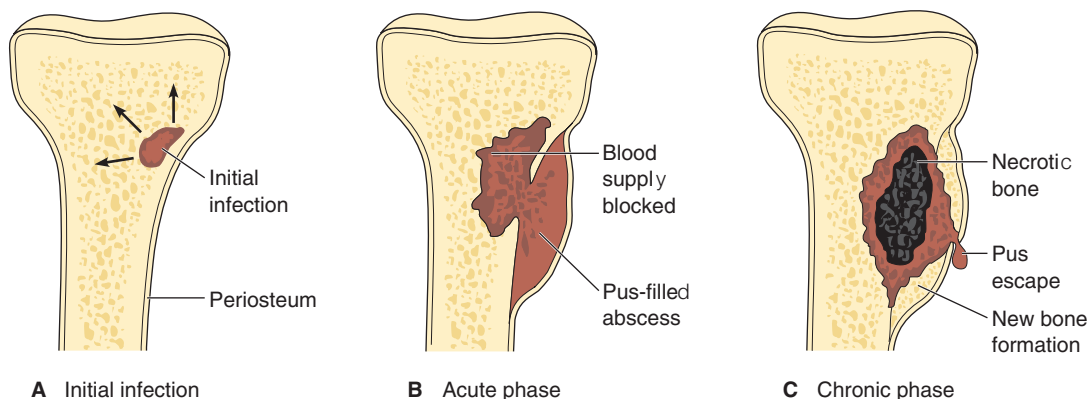


Figure 16-3 ► Three phases of bone infection.

Unfortunately, osteoporosis can quietly become advanced because no symptoms accompany bone loss until bones weaken enough to fracture. Weightbearing bones of the vertebrae and pelvis are especially susceptible to fracture. Accumulated compression fractures in these bones cause a decrease in height and bending of the spine (Figure 16-4 ►), and compressed vertebrae can press on spinal nerves, causing great pain.

Osteoporosis is diagnosed using patient history and bone density tests. No cure exists, so prevention is strongly recommended. A lifelong diet rich in calcium and vitamin D along with weightbearing exercise stimulates the development of dense and strong bone and slows progression of the disease. Smoking should be avoided, and alcohol and caffeine consumption should be minimized. Treatment may require medication that promotes calcium uptake in bone.

Rickets is a rare disease of infancy or early childhood in which the bones do not properly ossify, or harden. A child with rickets develops bones that are soft, bend easily, and over time become deformed.

Rickets can be prevented with vitamin D-fortified milk and exposure to sunlight. Sunlight converts a substance (dehydrocholesterol) in the skin to vitamin D in the body. Children with rickets respond well to sunlight exposure and treatment with vitamin D concentrate.

Osteomalacia is the softening or decalcification of bones in adults. Osteomalacia is rare in the United States. It is most prevalent in Asia among women who have had multiple births, eat a cereal-based diet, and have little exposure to sunlight. Symptoms include muscle weakness, weight loss, and bone pain. Bones of the vertebral column, legs, and pelvis readily bend and fracture under mild stress.

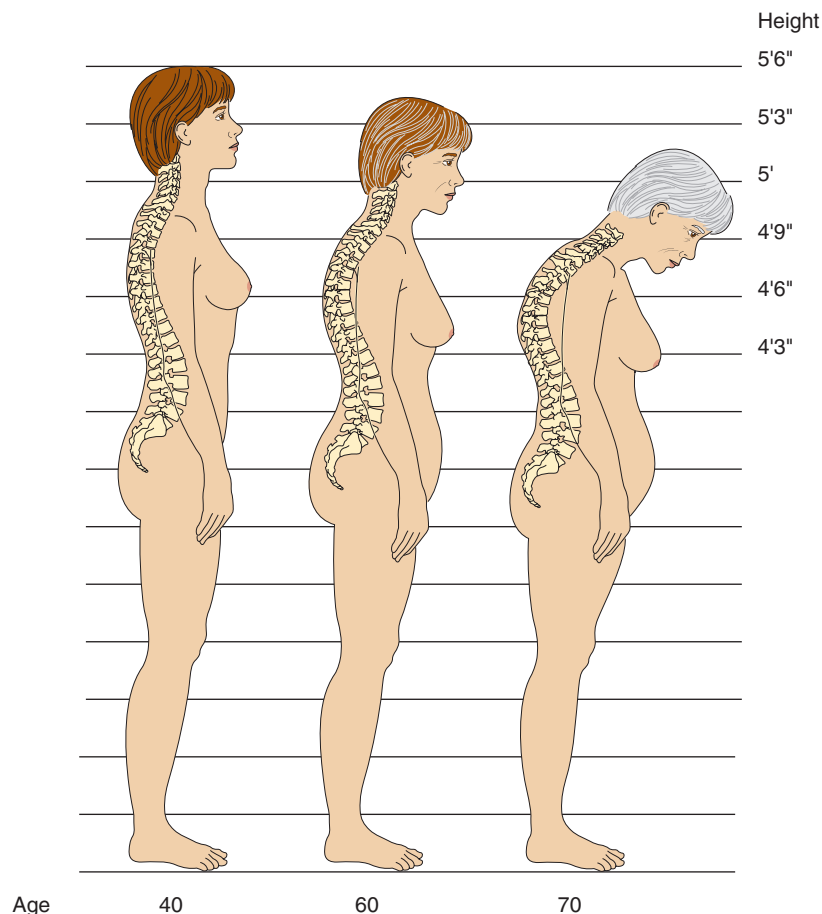


Figure 16-4 ► Spinal changes caused by osteoporosis.

Promote Your Health

Preventing Osteoporosis

Prevention should begin early in life and continue through adulthood. Adults need about 1,200 mg of calcium each day. This can be obtained by eating a variety of these foods:

- Dairy products
- Dark green leafy vegetables
- Calcium-fortified foods
- Almonds

Weightbearing exercise also builds bone density. Take part in some of these activities daily:

- Walking, jogging, or running
- Tennis or racquetball

- Field hockey
- Stair climbing
- Jumping rope
- Basketball
- Dancing
- Hiking
- Soccer
- Weightlifting

1. How do weight-bearing exercises promote strong, dense bones?
2. Why do women have a higher risk for osteoporosis than men?

Osteomalacia is caused by inadequate dietary vitamin D and dietary deficiency of calcium or phosphorus. It is treated with vitamin D supplements and adding adequate calcium and phosphorus to the diet.

Other Bone Deformities

Paget's disease, or **osteitis deformans**, results in overproduction of bone, particularly in the skull, vertebrae, and pelvis. Paget's disease is rare worldwide, but in the United States it

SIDE by SIDE

Osteoporosis



► X-ray of pelvis in 18-year-old female showing normal bone density. (© B. Bates/Custom Medical Stock Photo)



► X-ray of female pelvis with osteoporosis. Note greatly decreased bone density, especially visible in the hip bones. (© Custom Medical Stock Photo)

affects approximately 2.5 million people, mostly men over age 40. The risk for Paget's disease is unknown, but 20–30% of cases appear to be genetically based.

The disease begins with bone softening, which is followed by bone overgrowth. The new bone tissue is abnormal and tends to fracture easily. The excessive bony growth causes the skull to enlarge, which presses on cranial nerves and impairs vision and hearing. Abnormal bone development produces curvatures in the spinal column and deformities in the legs. Another complication of this disease is **osteogenic sarcoma** (see “Bone Cancer,” later in the chapter).

Paget's disease is diagnosed by examination, x-ray, bone scan, and bone biopsy. Treatment requires calcitonin and etidronate, which reduce bone resorption, and mithramycin, which decreases calcium.

Scoliosis is an abnormal lateral curvature of the spine that is usually first identified during childhood. Scoliosis may be caused by fusion of

the vertebrae during development, a neuromuscular abnormality, or weak or asymmetric back muscle development. Finally, scoliosis may be idiopathic. Symptoms may include lower back pain and fatigue. Diagnosis is based on history, physical exam, and x-rays. Mild curvatures of less than 20 degrees are common in adolescents and may require no treatment. More severe curvatures in growing adolescents must be treated with braces or surgery. The prognosis is positive following treatment. However, neuromuscular scoliosis may be more difficult to treat because it is usually related to another disease such as muscular dystrophy, spina bifida, or cerebral palsy. Scoliosis cannot be prevented.

Kyphosis (“hunchback”) is an exaggerated posterior curve of the thoracic spine that first occurs in adulthood and becomes quite noticeable in older adults (Figure 16–5 ►). It is most often caused by collapse of vertebrae affected by osteoporosis or by degenerative changes associated with arthritis of the vertebrae. Symptoms include

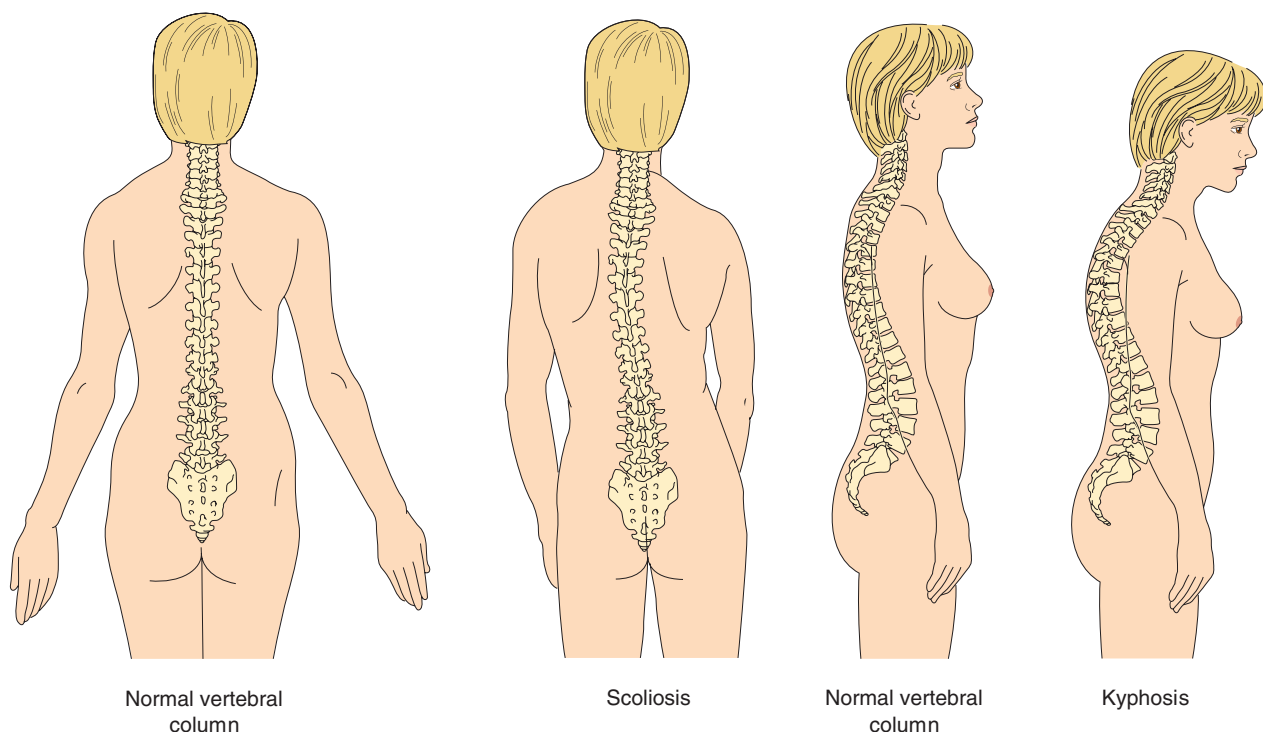


Figure 16–5 ► The two most common deformities of the spinal column are scoliosis and kyphosis.

mild back pain, back fatigue, tenderness, and, in severe cases, difficulty breathing because of compression of the thoracic cage. It can be diagnosed with physical exam and x-rays. Treatment options are few and provide no cures. Treatment of the underlying osteoporosis can slow progression of kyphosis. Treatment of underlying arthritis can relieve pain and immobility but only to a limited degree. Kyphosis cannot be prevented except by reducing the risk for osteoporosis.

Lordosis (“swayback”) is an inward curvature of the lumbar vertebrae. Some degree of curvature is normal and most cases of lordosis are benign. Any unusual pain or curvature should be evaluated.

Bone Cancer

Bone cancer presents as malignant bone tumors. Primary bone cancer is uncommon, comprising 1% of malignancies. Primary malignancy of bone occurs most often in males, especially children and adolescents. One type of bone cancer, **osteogenic sarcoma**, arises in the bony tissue itself and frequently affects the ends of long bones, especially the knee. The cause of osteogenic sarcoma is unknown. Signs and symptoms include dull localized pain that intensifies at night, bony masses, and fractures near the sarcoma. Bone cancer is diagnosed with biopsy, and x-ray and CT are used to locate and measure tumors. Treatment may involve chemotherapy to reduce tumor size followed by surgical removal. Bone cancer cannot be prevented.

Bone Trauma: Fractures

Trauma is the leading cause of bone fractures. Several diseases and disorders discussed in this chapter cause bone damage and raise the risk for fractures. The chief signs and symptoms of a fracture include:

- Visibly out-of-place limb or joint
- Swelling, bruising, or bleeding
- Intense pain
- Numbness and tingling
- Broken skin with bone protruding
- Limited mobility or inability to move a limb

These signs and symptoms require diagnosis and medical attention in order to promote healing and to prevent infections. A variety of fractures can occur (Figure 16–6 ►). Most fractures require immobilization with a splint or cast, whereas others, such as compound fractures, require surgery, pins, and plates to promote healing.

Diseases and Disorders of the Joints

Diseases of the joints cause pain and limit mobility. Joints that bear weight—the lower vertebrae, hips, and knees—receive a great deal of stress and are especially susceptible to the trauma, arthritis, and other disorders discussed in this chapter. Muscles, nerves, and bones may also be affected by joint diseases and disorders.

Arthritis

Arthritis means “inflammation of a joint.” Symptoms of arthritis include persistent joint pain and stiffness. Joints may swell, lose mobility, and become deformed and nonfunctional. Commonly affected joints include the lower vertebrae, hips, fingers, and knees.

Rheumatoid Arthritis A chronic and debilitating autoimmune disease, rheumatoid arthritis is a systemic inflammatory disease that affects several joints and the surrounding muscles, tendons, and ligaments. Rheumatoid arthritis affects more than 1 million Americans. Risk factors include family history of rheumatoid arthritis, gender (more common among females), age (onset is usually between ages 30 and 60), and smoking. The cause of rheumatoid arthritis remains unknown, but it appears to be an autoimmune disease.

The pathogenesis involves **rheumatoid factors** that form antibody complexes in the synovial fluid. This attracts neutrophils into the joint, which cause inflammation and destruction of the synovial joint tissues.







Fracture type	Description	Comments
<p>Closed</p> 	<p>Bone breaks cleanly but does not penetrate skin.</p>	<p>Also called a simple fracture.</p>
<p>Open</p> 	<p>Broken ends of bone protrude through soft tissues and skin.</p>	<p>Serious; may result in osteomyelitis. Also called a compound fracture.</p>
<p>Comminuted</p> 	<p>Bone fragments into many pieces.</p>	<p>Common in those with conditions causing brittle bones, such as osteogenesis imperfecta.</p>
<p>Compression</p>	<p>Bone is crushed.</p>	<p>Common in clients with osteoporosis.</p>
<p>Impacted</p>	<p>Broken ends of bone are forced into each other.</p>	<p>Common results from falls; also common in hip fracture.</p>
<p>Depressed</p> 	<p>Broken bone is pressed inward.</p>	<p>Common in skull fractures.</p>
<p>Spiral</p> 	<p>Jagged break due to twisting force applied to bone.</p>	<p>Common fracture due to sports injuries.</p>
<p>Greenstick</p> 	<p>Bone breaks incompletely, much in the way a green twig breaks.</p>	<p>Common in children, whose bones have proportionally more organic matrix and are more flexible than those of adults.</p>

Figure 16-6 ► Fractures.

Symptoms include joint pain and stiffness, particularly on waking. The joints become swollen, red, and warm. The same joints are often affected on both sides of the body. Additional signs and symptoms include fatigue, weakness, and weight loss. As rheumatoid arthritis progresses, joint tissue is replaced with a thickened granulation called a *pannus*. Further destruction results in joint erosion, scarring, and fusion, a condition called **ankylosis**. Figure 16-7 ► illustrates the crippling swan-neck deformity and ulnar deviation characteristic of advanced rheumatoid arthritis.

Diagnosis is based on physical exam, x-ray showing joint changes, a rheumatoid factor test, and synovial fluid analysis. Treatment must begin early to be most effective. Medical treatment includes disease-modifying antirheumatic drugs (DMARDS), which are the treatment of choice, and should begin as soon as possible. Anti-inflammatory and immune-suppressants may also be used to control the disease. Treatment includes a balance between exercise and rest. Rheumatoid arthritis cannot be prevented.

Osteoarthritis Osteoarthritis is the most common form of arthritis. Osteoarthritis affects 27 million Americans, men and women equally, usually after age 40. Osteoarthritis may be described as primary or secondary. Primary osteoarthritis occurs with normal aging, while secondary



Figure 16-7 ► Contractures of rheumatoid arthritis.

osteoarthritis is associated with joint injury, trauma, or obesity. Other than injury and age, risk factors and causes are not well understood.

Signs and symptoms include pain and stiffness in the joint. Muscle tension and fatigue contribute to the aches and pain of osteoarthritis. Affected joints lose their range of motion, and associated muscles might weaken.

Degeneration occurs at the articular cartilage that caps the bone surface where bone meets another bone in a joint. As this cartilage degenerates, underlying bone becomes exposed and damaged, which leads to new bone deposits in and around the joint. The bone ends thicken and develop sharp irregular bony surface structures called *spicules* and **spurs**. As a result, small joints such as the knuckles enlarge and become knobby (Figure 16-8 ► and Figure 16-9 ►).

Diagnosis of osteoarthritis requires a physical exam, history, and may include x-ray of the affected joint. There is no cure for osteoarthritis, but treatment can relieve the pain. A combination of rest, mild exercise, and heat application can maintain range of motion. Medical treatment commonly includes anti-inflammatory medications, and steroids such as cortisone may be injected into the joint capsule to relieve inflammation and pain. A severely damaged knee or hip

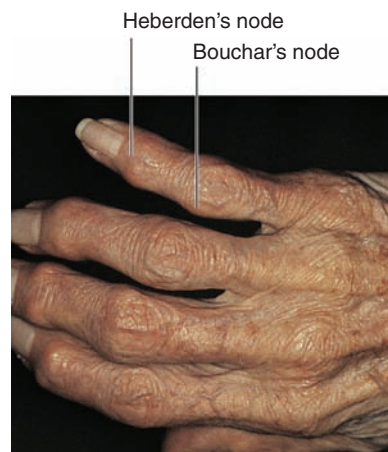


Figure 16-8 ► Typical joint changes associated with osteoarthritis. (Courtesy of the American College of Rheumatology)



Tophi lumps

Figure 16-9 ► Acute arthritis of the finger joints. (Courtesy of the American College of Rheumatology)

joint can be surgically replaced. Osteoarthritis cannot be prevented.

Gout Also called gouty arthritis, **gout** affects the joints of the feet, particularly the metatarso-phalangeal joint of the great toe. Gout affects an estimated 3 million Americans. The risk for

gout is highest for men over age 40 and for post-menopausal women. Other risk factors include a minor injury, excessive eating or drinking, or heredity.

The pathogenesis of gout is better understood than its cause. Gout attacks are related to excess uric acid in blood, which results either from a defect in metabolism of purines (a component of nucleic acids), or from abnormal retention of uric acid, or both. The high uric acid level leads to deposits of uric acid crystals in the joints. Uric acid crystals also deposit in the kidneys, stimulating kidney stone formation and irritating the kidney.

The onset of an acute attack of gout is generally sudden. The affected joints exhibit typical signs of inflammation: pain, heat, swelling, and redness. Signs and symptoms may last from days to many weeks. Resolution of an acute attack may be followed by symptom-free periods of 6 months to more than 2 years before recurrence. A chronic form of gout also occurs.

Gout can be diagnosed by microscopic examination of aspirated joint fluid, which reveals needlelike urate crystals. High serum level of uric acid is consistent with gout. X-rays of affected joints may initially appear normal until repeated attacks of chronic gout damage the bone and cartilage at joints.

Acute gout attacks can be treated with rest, application of hot or cold compresses, analgesics, colchicine, and corticosteroids. Chronic gout may be treated with colchicine, which prevents acute attacks, and agents that promote excretion of uric acid. If diagnosed early and treated properly, the development of chronic gout can be prevented.

Septic Arthritis Septic arthritis is considered a medical emergency. It develops as a result of bacterial infection of a joint. Cartilage and bone destruction may lead to ankylosis and life-threatening septicemia (bloodborne bacterial infection). Streptococci and staphylococci cause septic arthritis by invading a joint following trauma or surgery. *Neisseria gonorrhoeae*, the cause of gonorrhea, may spread to joints via blood from a primary infection site. Antibiotics are required to control the joint infection and to prevent septicemia.

Healthy Aging

Preventing Falls

Most fractures in older adults result from falls and most fall-related deaths occur among older adults. Older adults can take action to reduce their risk of falling. The Centers for Disease Control and Prevention recommends that older adults do the following to prevent falls:

- Exercise regularly to maintain strength and balance
- Review all medicines with doctor to determine if any cause side effects or interactions such as dizziness or drowsiness
- Check vision annually
- Reduce tripping hazards on floors and stairs at home.
- Install hand rails on stairs, in bathtubs and showers, and near toilets.

Bursitis

Bursae are small, synovial fluid-filled sacs located near the joints that cushion and reduce friction during movement. **Bursitis** is a painful inflammation of bursae, typically those of the shoulder joint. The pain of bursitis usually reduces joint mobility. Causes include repetitive motion, irritation, or injury of a bursa. Treatment includes rest, anti-inflammatories, moist heat applications, and steroids may be injected into the joint to reduce inflammation. It may not be possible to prevent bursitis, except by reducing potential triggers.

Joint Trauma

Herniated discs are ruptures of the cartilaginous pads between the bony bodies of adjacent vertebrae (Figure 16-10 ►). Herniated discs are the main cause of lower back pain, one of the most common orthopedic problems in the United States. Risk factors include age, obesity, trauma, and genetics. Typically occurring in the lumbar region, a herniated disc presses on nearby tissue and nerves, causing pain and immobility. A herniated disc may be treated with anti-inflammatories, analgesics, and surgery. Herniated discs cannot be prevented except by reducing the known risk factors.

Prevention PLUS!

Bones, Joints, and Muscles Benefit from Exercise

In a healthy aging body, muscles lose strength and coordination, bones become thin and brittle, and joints stiffen and lose flexibility. The consequences include greater risk for falls and fractures. These can result in immobility, disability, diminished quality of life, and susceptibility to depression and disease. A vigorous exercise program benefits the bones, joints, and muscles as well as the cardiovascular and respiratory system.

Think Critically

1. How does exercise affect the bones, joints, and muscles?
2. What kind of exercise benefits a person with arthritis?

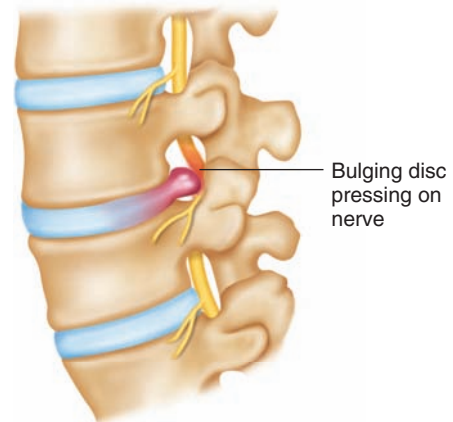


Figure 16-10 ► Herniated disc.

A **dislocation** is a displacement of bones from their normal position in a joint. Dislocations are most common in the shoulder and finger joints, but they can occur anywhere. A joint dislocation causes pain and reduced mobility at the involved joint. The bone must be reset and immobilized to allow healing of torn ligaments and tendons. Congenital dislocations of the hip result from an improperly formed joint, and they are treated in infancy with a cast or surgery.

Sprains result from the wrenching or twisting of a joint such as an ankle that injures the ligaments. Blood vessels and surrounding tissues, muscles, tendons, and nerves may also be damaged. Swelling and discoloration due to hemorrhaging from the ruptured blood vessels occur. A sprain is very painful, and the joint should not be used while it is severely inflamed. Immobilization with a splint or cast might be necessary for more severe sprains. Cold compresses reduce the swelling immediately after the injury, whereas later, heat applications relieve discomfort and speed healing. A “whiplash” is a sprain in which the cervical (neck) ligaments and tissues are injured. Whiplash injuries are often the result of rear-end motor vehicle accidents.

Strains, also called *pulled muscles*, result from a tearing of a muscle and/or its tendon from excessive use or stretching. Conditioning and warm-up before exercise prevent strains.

Strains should be treated with rest, initially with ice to reduce inflammation, and later with warm compresses to encourage blood flow and healing. Severe strains may require many months to heal before safely resuming activity.

RICE for Joint Trauma Sprains and strains cause swelling, pain, and some tissue damage. RICE (rest, ice, compression, elevation) is a simple and effective treatment for strains and sprains. Rest immobilizes a joint, which prevents further damage. Ice application reduces inflammation and pain. Ice should be applied for 10 minutes at a time several times per day. Compression with a bandage immobilizes the joint and reduces inflammation. Elevation of the joint, above heart level if possible, reduces blood flow to the joint, which also reduces inflammation and pain.

Carpal Tunnel Syndrome

A painful condition of the hand known as carpal tunnel syndrome (CTS) affects up to 10% of the working population in the United States, causing disability and lost work time. CTS is one of a larger class of problems known as repetitive motion injuries. Women are three times more likely to develop CTS than men. Many women report the symptoms during pregnancy, which is attributed to accumulation of fluid within the tissues. Risk factors for CTS include the performance of repetitive manual tasks such as knitting, driving, typing, computing, and piano playing (Figure 16–11 ►). It usually begins as numbness or tingling in the hand but progresses to pain that can radiate up the arm to the shoulder; the pain is most severe at night. Simple tasks requiring finger movements become difficult.

Diagnosis includes physical exam, history, electromyogram, and nerve conduction study to measure the velocity of nerve conduction. If electrical impulses are slowed as they travel through the wrist's carpal tunnel, compression of the nerve is indicated.

Conservative treatments begin with avoiding the repetitive action where possible, at least temporarily. Immobilizing the hand and wrist with a lightweight, molded plastic splint

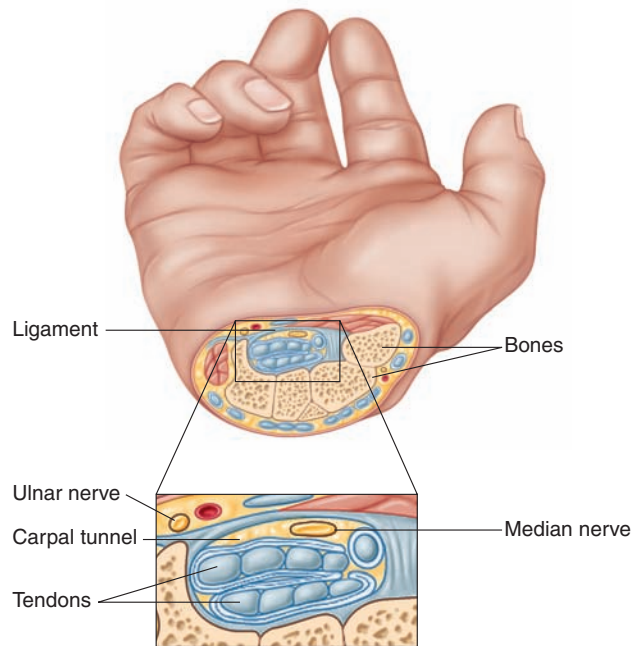


Figure 16–11 ► Cross section of the wrist showing tendons and nerves involved in carpal tunnel syndrome.

often permits the inflammation to subside. Treatment may include injection of a steroidal anti-inflammatory drug into the carpal tunnel. Surgery may be required to divide the wrist's transverse ligament to relieve compression of the median nerve. The procedure generally provides permanent relief without affecting hand movement or strength.

Prevention PLUS!

Carpal Tunnel Syndrome: An Occupational Hazard

Carpal tunnel syndrome, caused by damage to the median nerve, is a common problem of computer users, typists, beauticians, pianists, and dentists, who often maintain a flexed wrist position.

Think Critically

1. How can you prevent this injury?
2. Explain how this injury is treated.

Diseases of the Muscles

Muscular Dystrophy (MD)

Several forms of **muscular dystrophy (MD)** occur, all of which are hereditary. The various forms are transmitted differently and affect different muscles, but all result in muscle degeneration and physical disability. The most common and serious type is Duchenne's MD, which is caused by a sex-linked gene that affects approximately 2 per 10,000 people. MD can appear at any age, but generally signs appear between the ages of 3 and 5 years.

In Duchenne's MD, a cytoskeletal protein called **dystrophin** is missing. This defect results in the death of muscle fibers, which are then replaced by fat and connective tissue. The skeletal muscles progressively weaken, sometimes rapidly. In the most severe form, heart muscle is affected, the calf muscles enlarge as a result of fat deposition, a child becomes weak and thin, and the child does not usually live to adulthood.

The diagnosis is based on electromyography, which shows weak muscle contractions, and biopsy of muscle that reveals abnormal muscle fibers, variation in fiber sizes, fat deposits, and absence of dystrophin. Immunologic and molecular biology techniques can diagnose the disease prenatally as well as at birth.

Treatment includes physical and occupational therapy, exercise, and use of orthopedic appliances. No cure or prevention exists.

Myasthenia Gravis (MG)

Myasthenia gravis (MG) is a disorder of the myoneural junction in which the nerves fail to transmit an impulse for contraction to the muscles, leading to muscle atrophy. MG is rare and occurs more frequently among women than men. No risk factors are known. The cause is unknown, although MG is considered an autoimmune disease because research shows that antibodies attach near the myoneural junction and destroy acetylcholine or its receptors.

The principal symptoms of this disease are fatigue and the inability to use the voluntary muscles, including muscles of facial expression

and eyelids. As the disease progresses simple actions such as chewing and talking become difficult. The greatest danger in this disease is respiratory failure because the muscles required for respiratory ventilation are unable to contract.

Treatment includes drugs that increase acetylcholine levels at the myoneural junction. The thymus gland, which is involved in the immune response, is often enlarged in MG patients. Thus, removal of the thymus may bring about a remission but not a cure. MG cannot be prevented.

Tumors of Muscle

Muscle tumors are rare, but when they occur, they are usually malignant. Muscle malignancy is rare because muscle cells do not continually divide like blood or epithelial cells. A malignant tumor of skeletal muscle is called a **rhabdomyosarcoma**. The tumor requires surgical removal, and the prognosis is poor because rhabdomyosarcoma metastasizes early and is usually an advanced malignancy when it is diagnosed. Rhabdomyosarcoma cannot be prevented.

Age-Related Diseases

Bones

The amount, density, and strength of bone declines steadily with age, partly because osteoblast activity declines with age. At menopause, bone loss accelerates, making women more susceptible to osteoporosis and its effects. More than 80% of those with osteoporosis are women, and a majority of women over age 60 have low bone density or osteoporosis.

Joints

Joint mobility decreases with age because cartilage becomes stiff, ligaments lose flexibility and elasticity, and synovial membranes become fibrous, stiff, and produce less synovial fluid. These changes begin at age 20 and become significant by age 30, especially if the joints

and muscles are not regularly exercised and stretched. The incidence of arthritis increases with age: While fewer than 20% of young adults have arthritis, 60% of adults over age 60 have some form of arthritis. Most of these cases are osteoarthritis.

Muscles

With age, the number of muscle fibers decreases, and they become shorter and thinner, reducing muscle strength and range of motion. Muscles become less sensitive to stimulation with age,

meaning that they take longer to contract when stimulated. Recovery following contraction becomes slow, diminishing the ability to sustain repeated contractions and reducing endurance. Exercise reduces the rate of these changes and helps maintain muscle mass, strength, and flexibility.

Resources

American Academy of Orthopedic Surgeons: www.aaos.org
American College of Sports Medicine: www.acsm.org
American Physical Therapy Association: www.apta.org

Diseases at a Glance

Musculoskeletal System

Disease	Etiology	Signs and Symptoms
Osteomyelitis	Infection by staphylococci	Pain, redness, heat, chills, fever, tachycardia, nausea, weight loss
Rickets	Vitamin D deficiency in childhood	Deformation of bones, knock-knee, bow-leg, curved spine, nodular swellings at rib ends and joints, enlarged and square head, flaccid muscles
Osteomalacia	Vitamin D deficiency in adults	Muscular weakness, weight loss, pain in bones, deformation of bones, easily fractured bones
Osteoporosis	Calcium deficiency, decreased bone density	Decreased height from vertebral compression fractures, curvature of spine, easily fractured bones
Paget's disease	Idiopathic, genetic	Enlarged skull, nerve compression curvatures in spine, deformed legs
Bone tumors	Idiopathic; commonly metastatic	Painless lump in bone tissue, fracture without trauma
Rheumatoid arthritis	Autoimmunity	Pain and stiffness in joints; swollen, red, warm joints; bilateral involvement; exacerbation and remission; rheumatoid nodules; crippling deformities
Osteoarthritis	Idiopathic; may follow joint injury or chronic irritation	Aches, pain, stiffness in joints, limited range of motion, muscle weakness around affected joint, enlarged joints, bone spurs; may involve only one joint
Gout	Inherited defect in uric acid metabolism leads to high levels of urate and uric acid deposition in joints	Severe pain, heat, swelling, redness in affected joint; acute onset
Septic arthritis	Bacterial infection of joint	Pain, redness, swelling, bone and joint destruction

Diagnosis	Treatment	Prevention	Lifespan
Bone biopsy, CT, MRI, WBC count	Antibiotics, surgery	Antibiotics for compound fractures or other infected wounds	Any age
Physical exam, x-ray	Vitamin D–fortified milk, sunlight, cod liver oil	Vitamin D–fortified milk or supplements, sunlight, cod liver oil	Children
Physical exam, x-ray	Vitamin D–fortified milk, sunshine, cod liver oil, calcium and phosphorous supplements	Vitamin D–fortified milk or supplements, sunlight, cod liver oil, calcium and phosphorous supplements	Adults
X-ray and bone scan	Pain relief, fracture treatment, some medical treatment	Calcium supplements, weightbearing exercises	Postmenopausal women
Physical exam	Surgical, limited	None	Older men
X-ray, biopsy	Surgery	None	Children and adolescents
Physical exam, presence of rheumatoid factor in blood	Mild exercise, anti-inflammatories, steroids	None	Adults
X-ray, physical exam, history	Pain relief, mild exercise and rest, heat applications, steroids, surgery	None	Adults
Uric acid level in blood, x-ray	Analgesics, hot and cold compresses, medicines that lower uric acid levels	Avoid triggers, which may be dietary	Men over age 40
History, blood and synovial cultures	Antibiotics	Treat infected wounds or other infections with antibiotics to prevent sepsis	Any age

Disease	Etiology	Signs and Symptoms
Bursitis	Overuse of joint	Pain at joint, especially during use
Carpal tunnel syndrome	Repetitive use of wrist	Numbness and tingling of hand, pain radiating to shoulder, limited finger movement, severe at night
Muscular dystrophy	Defect in X-linked gene for muscle protein dystrophin	Weakened muscles, muscles may enlarge as fat is deposited; muscles degenerate
Myasthenia gravis	Autoimmunity interferes with nerve transmission to muscles	Fatigue, muscle paralysis

Diagnosis	Treatment	Prevention	Lifespan
Physical exam and history	Moist heat, analgesics, steroids, rest	Reduce or avoid triggering activities	Adults
Physical exam, history, nerve conduction study, electromyography	Splinting hand and wrist, surgery	Reduce or avoid triggering activities	Adults and adolescents
Physical exam, serum enzymes, muscle biopsy	Physical therapy, orthopedic procedures	None; screening helps detect early onset	Onset in young adults
Antibody level, response to anticholinesterase drugs, electromyography	Thymectomy, anticholinesterase drugs, steroids, immune suppression	None	Onset in young adult women

Interactive Exercises

Cases for Critical Thinking

1. A 68-year-old woman visits her physician and reports that her back hurts. Physical exam finds kyphosis and that she has lost height since her last visit a few years ago. What is a likely diagnosis for this case? Name two treatment possibilities that the physician might suggest. Name something that might have helped prevent this condition, especially if it had been initiated and applied at an earlier age.
2. A 55-year-old carpenter reports persistent swelling and pain in the knuckles of his right hand. What information do you need to determine the type of joint disease he has?
3. A 20-year-old woman has worsening pain in her leg below the knee. She says she feels “a little weak and out of sorts” and has stopped her jogging routine. How can you determine whether she has a type of arthritis, a bone infection, a fracture, or a joint sprain?

Multiple Choice

1. Bones are soft in rickets due to a _____ deficiency.
 - a. vitamin A
 - b. vitamin C
 - c. vitamin D
 - d. vitamin K
2. Osteomalacia affects which of the following?
 - a. the joints of young children
 - b. the joints of adults
 - c. the bones of children
 - d. the bones of adults
3. Carpal tunnel syndrome is caused by damage to the _____.
 - a. wrist
 - b. fingers
 - c. median nerve
 - d. forearm muscles
4. Biopsy in addition to electromyography is a diagnostic test for _____.
 - a. gout
 - b. sprain
 - c. carpal tunnel syndrome
 - d. Duchenne's MD
5. _____ is the most common form of arthritis.
 - a. Rheumatoid arthritis
 - b. Osteoarthritis
 - c. Septic arthritis
 - d. Gout
6. Ankylosis and immobility results from severe _____.
 - a. rheumatoid arthritis
 - b. osteoarthritis
 - c. septic arthritis
 - d. gout
7. Colchicine and immunosuppressants are used to treat acute cases of _____.
 - a. rheumatoid arthritis
 - b. osteoarthritis
 - c. septic arthritis
 - d. gout
8. Which of these is *not* due to calcium deficiency?
 - a. osteoporosis
 - b. osteomalacia
 - c. osteogenic sarcoma
 - d. rickets

9. Which of these is a type of autoimmune disorder?
- rhabdomyosarcoma
 - Duchenne's MD
 - myasthenia gravis
 - osteitis fibrosa cystica

10. Bacterial infection is the cause of _____.
- osteomalacia
 - osteoma
 - osteomyelitis
 - osteoporosis

True or False

- | | |
|--|---|
| <p>_____ 1. Osteomyelitis is a bone infection that occurs following bone trauma or in diabetics.</p> <p>_____ 2. Women with large bone mass are most prone to osteoporosis.</p> <p>_____ 3. An osteoma is a malignant bone tumor.</p> <p>_____ 4. Rheumatoid arthritis is the most crippling form of arthritis.</p> <p>_____ 5. Osteomyelitis is a systemic infection.</p> | <p>_____ 6. Osteoarthritis is the most common form of arthritis.</p> <p>_____ 7. Muscular dystrophy is a hereditary disease.</p> <p>_____ 8. Myasthenia gravis is an infectious disease of the muscles.</p> <p>_____ 9. Rhabdomyosarcoma is a malignant bone tumor.</p> <p>_____ 10. There is no cure for osteoarthritis.</p> |
|--|---|

Fill-Ins

- | | |
|---|---|
| <p>1. Tuberculosis of bone is caused by the bacterium _____.</p> <p>2. A disease of infancy and early childhood in which the bones do not properly ossify, or harden, is called _____.</p> <p>3. The word _____ means increased porosity of the bone, which makes the bone abnormally fragile.</p> <p>4. A very painful condition caused by deposits of uric acid crystals in the joints is called _____.</p> <p>5. The principal minerals in bone are _____ and _____.</p> | <p>6. Bone is deposited by cells called _____.</p> <p>7. The _____ membrane becomes inflamed in rheumatoid arthritis.</p> <p>8. Antibodies against acetylcholine receptors are the cause of _____.</p> <p>9. Colchicine is an effective treatment for _____.</p> <p>10. Vitamin D is required for intestinal absorption of _____.</p> |
|---|---|

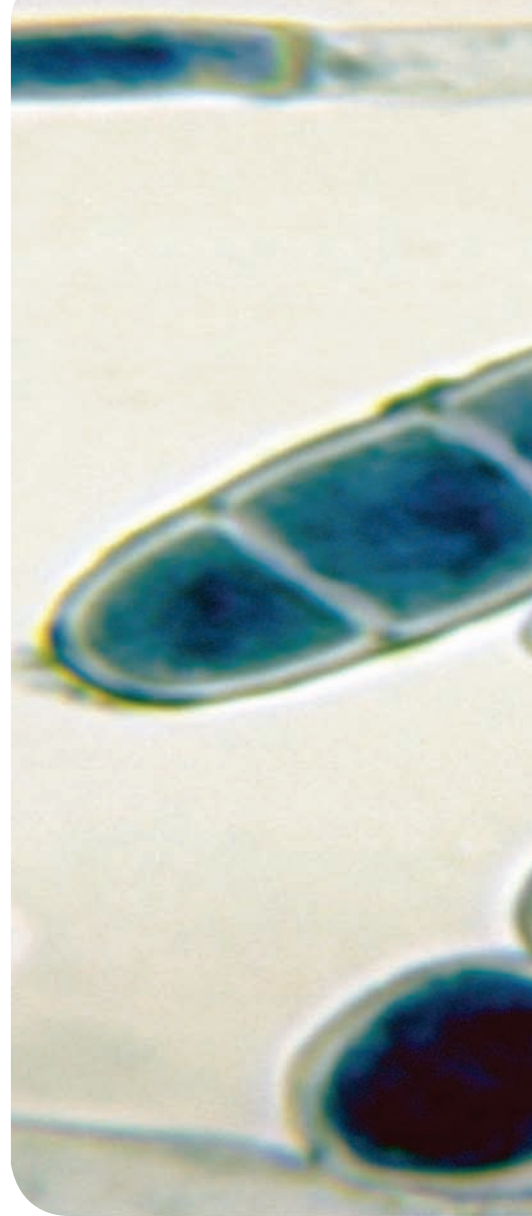
Chapter 17

Diseases and Disorders of the Integumentary System

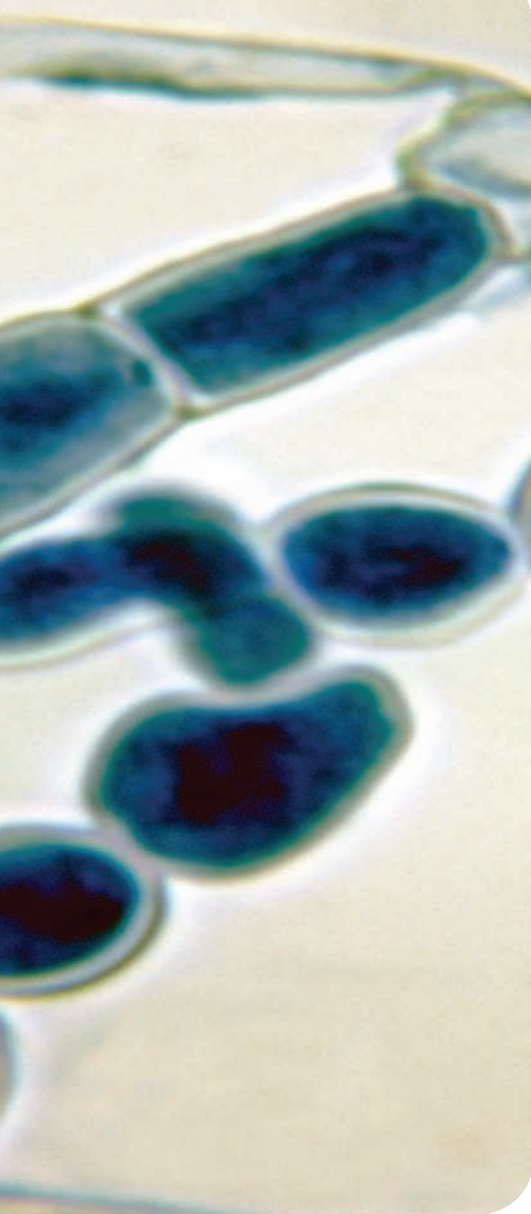
Learning Objectives

After studying this chapter, you should be able to

- Describe the normal structure and function of the integumentary system
- Describe the prevalence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for infectious diseases of the skin
- Understand the effects of hypersensitivity or immune disorders on the skin
- Define and differentiate the benign tumors of the skin
- Describe the prevalence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for nonmelanoma and melanoma skin cancer
- Explain the causes and treatments of sebaceous gland disorders
- Describe pigment disorders
- Describe different types of skin trauma
- Describe the prevalence, risk factors, signs and symptoms, etiology, diagnosis, treatment, and prevention for age-related diseases of the skin



Macroconidia of the dermatophytic fungus, *Epidermophyton floccosum*. (Courtesy of the Centers for Disease Control and Prevention/Dr. Libero Ajello, 1972)



Disease Chronicle

Acne Treatment

Acne is an ancient skin problem. Ancient Egyptians used spells and charms on the pharaohs who suffered from acne. Egyptians living during the 3rd century A.D. believed acne was caused from telling lies. During the Roman empire it was thought that pores could be unclogged and cleansed by mixing sulfur in mineral baths. Because this type of cleansing reduced the amount of bacteria that caused acne and dried out the oils that clogged the skin, it was fairly effective. In the 1920s, benzoyl peroxide was found to kill acne bacteria and became a popular acne treatment. In the 1950s, antibiotics were found to be an effective treatment for acne. In the 1960s, it was discovered that topical vitamin A derivatives could fight acne blemishes.

Fact or Fiction?

The average person sheds more than one pound of skin every year.

Fact: The outer layer of the epidermis is completely replaced every month.

Anatomy and Physiology Review

The integumentary system wraps the body in a protective cloak of skin, hair, nails, and associated glands. The skin is the largest organ of the human body, covering 17–20 square feet. Skin protects underlying tissues and organs from damage and infection, regulates temperature, senses pain, protects against dehydration, aids in the excretion of urea and uric acid, and synthesizes vitamin D.

The two layers of the skin, the epidermis and the dermis, lie above a layer of subcutaneous tissue. The epidermis is the outermost layer and varies in thickness from less than 0.1 mm (plastic sandwich bag) on the eyelids to more than 5 mm (paper towel) on the back. The cells of the outer layer of the epidermis regularly wear off, so the skin must continually replace the epidermis.

Most of the cells of the epidermis are keratinocytes, cells that produce keratin. Keratin is a tough, fibrous protein that makes the skin surface durable and prevents water loss. Melanin, a pigment that ranges in color from yellow to brown to black, is produced by melanocytes found at the bottom of the epidermis. Melanocytes exposed to

ultraviolet (UV) radiation produce more melanin pigment. Keratinocytes take up melanin and use it to shield their DNA from the damaging effects of UV radiation.

The dermis lies below the epidermis and is composed of fibrous connective tissue containing collagen and elastin fibers. Collagen provides mechanical strength, and elastin provides elasticity and flexibility. The dermis contains a variety of sensory receptors that provide information about the external environment.

The subcutaneous tissue lies below the dermis and connects the skin to underlying structures. Adipose tissue or fat cells in the subcutaneous tissue help insulate the body from heat and cold. Figure 17-1 ► shows the structure of the skin.

Sebaceous glands (oil glands) are found all over the skin except on the palms of the hands and the soles of the feet. Sebaceous glands secrete an oily substance called sebum into hair follicles and onto the surface of the skin. Sebum lubricates and moistens the skin and hair and has moderate antibacterial and antifungal effects.

Skin contains eccrine sweat glands and apocrine sweat glands. Eccrine sweat glands are found all over the body and produce sweat that

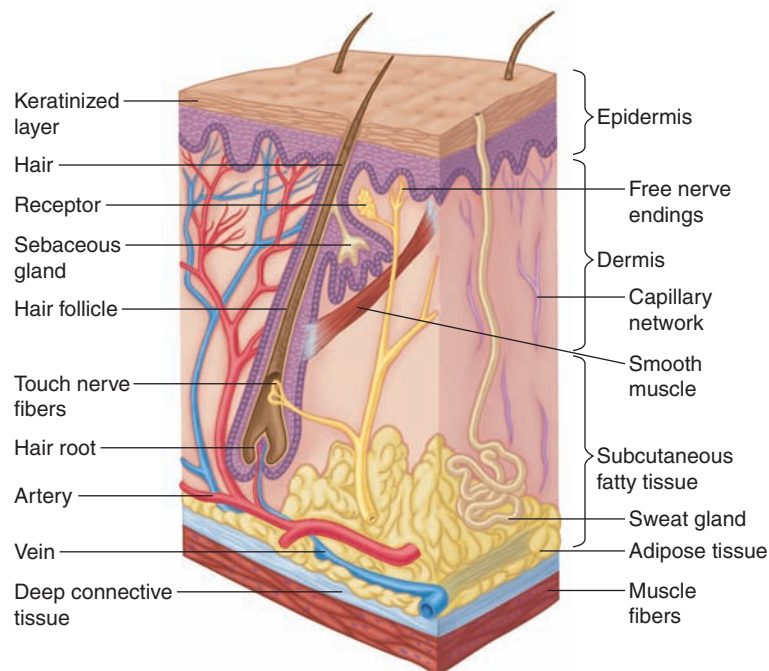


Figure 17-1 ► Structure of the skin.

Promote Your Health

Best Foods for Healthy Skin

Antioxidant-rich foods seem to have a protective effect for the skin. Consider these skin-friendly foods:

- Carrots, apricots, and other yellow and orange fruits and vegetables
- Spinach and other green leafy vegetables
- Tomatoes
- Blueberries
- Beans, peas, and lentils
- Salmon, mackerel, and other fatty fish
- Nuts

helps regulate body temperature. Apocrine sweat glands are located mainly in the axillary (armpit) and genital areas. Apocrine sweat glands begin to function at puberty. Sweat produced by these glands does not have a strong odor unless it accumulates on the skin. When this occurs, bacteria use substances in the sweat as a food source, resulting in body odor.

Hair projects above the surface of the skin everywhere on the body except the palms, soles, lips, nipples, and some areas of the genitals. A hair is an epidermal structure, composed of keratin and produced by a hair follicle. Eyebrow hair and eyelashes shield the eyes, and hairs in the nose filter out dust. The hair on the scalp insulates against heat and cold. The rest of the body's hair has no known function.

Nails are produced by epidermal cells. The visible part of the nail is called the nail body. The nail bed is located underneath the nail and normally appears pink because of its rich blood supply.

Diagnostic Tests and Procedures

Skin disorders and diseases are usually diagnosed by visual examination. Changes in skin color can indicate the presence of diseases or disorders within the body.

- **Cyanosis**, a blue tint to the skin, is caused by a deficiency of oxygen in circulating blood
- **Jaundice**, a yellow discoloration of the skin and the whites of the eyes, is caused by impaired liver function that allows bile to accumulate and stain the skin

- **Erythema**, abnormal redness of the skin, is caused by increased blood flow and dilated blood vessels close to the skin's surface
- **Pallor**, pale skin, is caused by decreased blood flow
- **Hematoma** or bruising is a bluish, black, or yellow mark on the skin and indicates the breakdown of clotted blood under the skin.

The shape and color of nails provides information about underlying diseases or disorders. Clubbing or enlargement of the ends of the nails is due to long-term oxygen deficiency. Pale nails may be a sign of anemia; flat or concave nail beds may indicate iron deficiency. Cyanosis of the nails is often the first visible sign of oxygen deficiency.

Diagnostic procedures may include microscopic examination of skin scrapings. Cultures, DNA testing, antigens, or antibodies may be used to identify the causative organism in infectious skin diseases.

In hypersensitivity skin disorders, a complete medical history, including prior outbreaks and locations of outbreaks, helps identify the allergen. Sensitivity testing or blood tests for antibodies are used to identify the allergen.

Biopsies are used to diagnose benign tumors and skin cancer. Types of biopsies performed include punch, incisional, or total excisional. In a punch biopsy, a round-shaped knife is rotated through the epidermis and dermis into the subcutaneous tissue. A punch biopsy yields a cylindrical core of tissue. In an incisional biopsy, a scalpel is used to make a cut through the epidermis and dermis down to the subcutaneous tissue. An incisional biopsy yields an elliptical

core of tissue. An excisional biopsy removes the entire lesion or tumor.

Skin Lesions

Some skin diseases are accompanied by characteristic lesions. These lesions include:

- **Macule**, or freckle, is a discolored spot of the skin.
- **Wheal**, or hive, is a localized elevation in the skin that is often accompanied by itching.
- **Papule**, or pimple, is a solid, elevated area on the skin. A nodule is a large papule.
- **Vesicle**, or blister, is a small, fluid-filled sac.
- **Pustule**, a small, elevated lesion filled with pus.
- **Ulcer**, an area of the skin in which the surface has eroded.

Figure 17–2 ► shows various skin lesions. Certain symptoms that can accompany lesions, including **pruritus** (itching), edema (swelling), erythema (redness), and inflammation, are helpful in making a diagnosis.

Epidermoid Cysts

An epidermoid cyst is a fluid-filled sac that forms from cells in the epidermis. Previously called a sebaceous cyst, this term is no longer used because these cysts do not originate from the sebaceous glands. Epidermoid cysts can appear anywhere on the skin, but they develop most commonly on the face, neck, chest, and upper back. The prevalence of epidermoid cysts is not known, but they are the most common cutaneous cyst. Epidermoid cysts can affect anyone, but risk factors include age (30s or 40s), gender (men are twice as likely to have epidermoid cysts), a history of acne, and a traumatic or crushing injury to the skin.

Epidermoid cysts are flesh-colored to yellowish, smooth, round, easily moved lumps just beneath the skin. Fortunately, epidermoid cysts are usually asymptomatic, although occasionally they become infected, leak, or form in an uncomfortable place such as in the genital skin folds or beside a nail. Epidermoid cysts are caused by abnormal cell proliferation, which can occur following an injury to the skin, a hair follicle,

or a sebaceous gland. The abnormally multiplying cells form a sac and produce keratin that becomes trapped inside. They are suspected to be hereditary or linked to a minor developmental defect.

Epidermoid cysts are easily diagnosed during a visual examination. If required, the cyst can be removed surgically. Epidermoid cysts are not preventable.

Infectious Skin Diseases

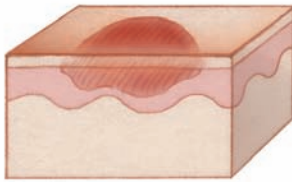
Bacteria, viruses, fungi, and parasites may cause infections of the skin. Most skin infections are caused by the microbes comprising the skin's normal flora.

Bacterial Skin Infections

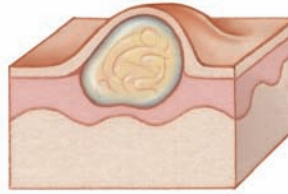
Impetigo Impetigo is an acute, highly contagious bacterial skin infection that occurs mainly among infants and children. Impetigo affects approximately 1% of children and accounts for approximately 10% of all skin problems in pediatric clinics. Risk factors for contracting impetigo include age (2–6 years), direct contact with a person with impetigo, contact with a contaminated fomite (an inanimate object that can transmit infectious agents), and attending school or daycare.

Signs and symptoms usually begin with red papule lesions with erythema. The papules fill with fluid and become vesicles that rupture a few days later, forming a thick honey-colored crust. Pruritis is common. The etiological agent of impetigo is staphylococcal or streptococcal bacteria that enter through a break in the skin. Diagnosis is made by visual examination and may include a culture. The lesions should be washed with soap and water, kept dry, and exposed to air. Impetigo is treated with antibiotics. Prevention includes daily bathing, frequent handwashing, and prompt attention to skin wounds.

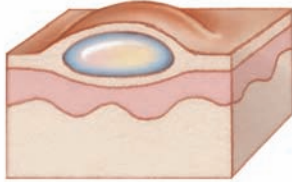
Erysipelas and Cellulitis Erysipelas is a superficial bacterial infection of the skin. Mild erysipelas is a common and usually self-limited infection. Thus, patients rarely seek a doctor for erysipelas and its prevalence is not known. **Cellulitis** is a deeper infection that extends to the subcutaneous tissue. The prevalence of cellulitis is



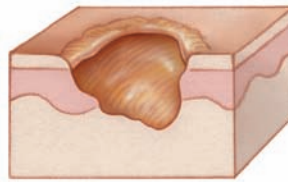
A macule is a discolored spot on the skin; freckle



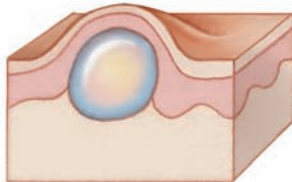
A pustule is a small, elevated, circumscribed lesion of the skin that is filled with pus; acne



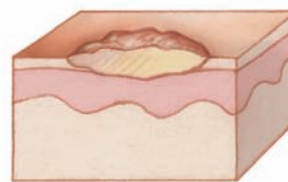
A wheal is a localized, evanescent elevation of the skin that is often accompanied by itching; urticaria



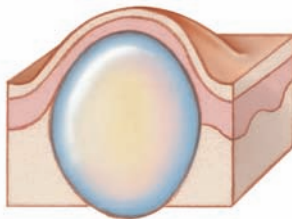
An erosion or ulcer is an eating or gnawing away of tissue; pressure ulcer



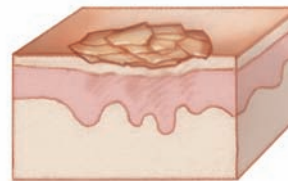
A papule is a solid, circumscribed, elevated area on the skin; pimple



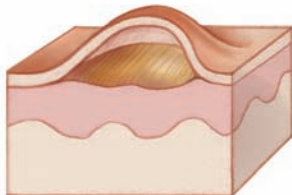
A crust is a dry, serous or seropurulent, brown, yellow, red, or green exudation that is seen in secondary lesions; impetigo



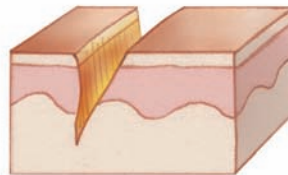
A nodule is a larger papule



A scale is a thin, dry flake of cornified epithelial cells; psoriasis



A vesicle is a small fluid filled sac; blister



A fissure is a crack-like sore or slit that extends through the epidermis into the dermis; athlete's foot

Figure 17-2 ► Skin lesions.

also unknown. Several risk factors increase the chances of developing erysipelas and cellulitis. These include impaired immunity, skin conditions such as eczema, athlete's foot, shingles, chronic swelling of the arms or legs, IV drug use, obesity, a history of having cellulitis, and trauma to the skin.

Erysipelas and cellulitis infections usually appear on the face or the legs. The involved area is generally swollen, bright red, hot, and tender (Figure 17-3 ►). Small vesicles may be present. Fever, chills, and swelling of lymph nodes may occur. The etiological agent of erysipelas and cellulitis is staphylococcal or streptococcal bacteria that enter through a break in the skin. Diagnosis is by visual examination and may include a culture. When the infection is severe, treatment includes antibiotics. Erysipelas and cellulitis can be prevented by cleaning and disinfecting skin wounds, keeping skin moisturized, and trimming fingernails short to avoid scratching the skin.

Folliculitis, Furuncles, and Carbuncles Each of these is an infection associated with hair follicles. **Folliculitis** is a superficial bacterial infection of the hair follicles, while **furuncles**, also called



Figure 17-3 ► Cellulitis indicated by redness and swelling around the eye. (Courtesy of the Centers for Disease Control and Prevention/Dr. Thomas F. Sellers/Emory University, 1963)

boils, are a deeper infection of the hair follicle. **Carbuncles** are larger, and consist of clusters of furuncles.

Many cases of folliculitis, furuncles, and carbuncles are not reported so their prevalence is not well known. Risk factors include several conditions that promote growth of bacteria in the hair follicles. For example, bacterial growth in the hair follicles takes advantage of impaired immunity, skin abrasions, cuts, and bruises. Bacteria also grow excessively in the skin folds of obese people, during long-term antibiotic therapy for acne, topical corticosteroid therapy, and while wearing clothing that can trap heat and moisture close to the skin (waders, high boots). Hot water in hot tubs, heated pools, and whirlpools can traumatize the skin and introduce bacteria to the hair follicles. The cause of these infections is usually the gram-positive bacterium *Staphylococcus aureus*. They can easily be diagnosed during a visual examination. If necessary, the bacteria can be cultured from the lesions. Folliculitis, furuncles, and carbuncles each may require different treatments. Shaving with care, keeping skin moist and well hydrated, avoiding unsanitary hot tubs and pools, and regular face- and handwashing may help prevent folliculitis, furuncles, and carbuncles.

Folliculitis is characterized by pruritis and red, bumpy papules or pustules that develop around hair follicles (Figure 17-4 ►). Treatment may include using an antiseptic cleanser and antibiotics.



Figure 17-4 ► The lesions of folliculitis are pustules surrounded by areas of erythema.

Furuncles and carbuncles are painful pustules that form in hair follicles (Figure 17-5 ►). Furuncles and carbuncles may be treated with application of moist heat, antiseptic skin cleansing, and antibiotics. If furuncles or carbuncles are large, they may need incision and drainage.

Viral Skin Infections

Oral Herpes Herpes is an extremely common viral skin infection. It is estimated that approximately 65% of the United States population is exposed to Herpes simplex type 1 (HSV-1) by the age of 40. HSV-1 is the etiological agent of skin infections known as cold sores or fever blisters. The known risk factors for HSV-1 infection include sharing utensils, food, and drinks with an infected person; kissing an infected person; and having oral-to-genital contact with an infected person. The virus usually affects the lips, mouth, and face, but it can cause genital herpes if transmitted during oral-genital sex.

The most common sign of herpes is clusters of painful fluid-filled vesicles on the skin (Figure 17-6 ►). Some patients have a burning or tingling sensation that precedes the appearance of the vesicles by a few hours or a day or two. Unfortunately, herpes is incurable. The virus remains inactive in nerve cells until something triggers the virus to become active again. Outbreaks can be triggered by a cold, flu, fever, sun exposure, stress, trauma to the skin, and impaired immunity. Diagnosis may include



Figure 17-5 ► A furuncle or boil.



Figure 17-6 ► Cold sores or fever blisters. (Courtesy of the Centers for Disease Control and Prevention/Dr. Herrman, 1964)

visual observation of the herpetic vesicles, HSV-1 antigen or antibody testing, culture, and testing for HSV-1 DNA. The outbreaks are usually self-limiting, but antiviral drugs can decrease the severity and duration of an outbreak. Oral herpes can be prevented by eliminating the risk factors. An infected person can prevent painful outbreaks by avoiding the triggers that bring on the outbreaks.

Herpes simplex virus-2 is the etiological agent of sexually transmitted genital herpes (see discussions of diseases of the reproductive system elsewhere in the text).

Warts Warts, or *verruca vulgaris*, are small, benign growths on the skin. There are few reliable studies on the prevalence of nongenital warts, but two studies suggest that warts affect less than 1% of the population in the United States and that prevalence probably varies widely among different age groups, populations, and periods of time. Risk factors include impaired immunity, age (children, young adults), walking barefoot on wet surfaces, sharing personal items with someone who has warts, and physical contact with warts. Warts are caused by infection with the human papillomavirus (HPV).

HPV infection causes keratinocytes to form a benign neoplasm with a rough, keratinized surface. Warts are most common at sites of trauma such as the hands and feet and probably result from inoculation of virus into damaged areas of epithelium. There are several types of warts, including common, plantar, flat, filiform, and periungual.

- **Common warts** are rough, dome-shaped, and gray-brown in color (Figure 17-7 ▶).
- **Plantar warts** grow inward on the soles of the feet, forming hard, thick patches of skin with dark specks.
- **Flat warts** occur on the face, arms, or legs, resemble small pencil erasers with flat tops, and can be pink, light brown, or light yellow.
- **Filiform warts** form around the mouth, nose, or beard area; they are the same color as the skin with growths that look like threads sticking out of them.
- **Periungual warts** grow under and around the toenails and fingernails and affect nail growth; they appear as rough bumps with an uneven surface and border.

Warts are easily diagnosed by visual examination. Although most warts resolve without treatment, some people prefer to have them removed. Warts can catch on clothing and other objects, tear, and bleed, which can be painful and lead to infections. Some people find the warts unattractive or embarrassing. Fortunately, many warts can be removed with medications that erode the toughened tissue. Warts can also be removed by electrocautery, the application of a heated needle or loop, by cryosurgery, by application of extreme cold to destroy the tissue, or with laser surgery. The best way to prevent HPV infections is to avoid touching warts, to wear sandals when walking on warm moist surfaces, and to treat skin cuts, abrasions, and burns.



Figure 17-7 ▶ Common warts.

Fungal Skin Infections

Fungal infections are caused by microscopic yeast and mold that live on the skin, hair, or nails. Superficial fungal infections are among the most common skin diseases, affecting millions of people throughout the world. The estimated lifetime risk of acquiring a fungal skin infection is between 10 and 20%. The risk for fungal skin infection is related to factors that reduce immunity or promote the growth of fungi. Thus, the risk factors include prolonged use of antibiotics or corticosteroids; chronic disease such as diabetes or cancer; immune deficiency; exposure to damp shoes, clothes, communal showers or locker rooms; and inherited susceptibility. Fungi are readily transmitted through direct contact with infected persons, animals, soil, or fomites. Fungi usually reside on moist areas of the body where skin surfaces touch, such as the skin folds of the breast, groin, and toes.

Tinea *Tinea*, or ringworm, is a superficial fungal infection of the skin or nail that is classified by its location on the body (Table 17-1 ▶).

- **Tinea corporis**, or body ringworm, affects smooth areas of skin on the arms, legs, and body. It is characterized by a rash that begins as a small area of red, raised spots and papules. The rash slowly becomes ring-shaped, with a red-colored, raised border and a clearer center. The border may look scaly (Figure 17-8 ▶).
- **Tinea pedis**, or athlete's foot, is the most common type of tinea worldwide. Scales and fissures on the soles of the feet and between the toes characterize tinea pedis (Figure 17-9 ▶).
- **Tinea cruris**, or jock itch, generally affects the groin and upper and inner thighs. The fungi cause red, ringlike areas with vesicles (Figure 17-10 ▶). Tinea cruris develops more frequently during warm weather.
- **Tinea capitis** (Figure 17-11 ▶), or scalp ringworm, is highly contagious and most commonly occurs in children. Signs and symptoms include single or multiple patches of hair loss that may have a black dot pattern, inflammation, scaling, pustules, and pruritis.
- **Tinea unguium**, or nail fungus, typically affects toenails and rarely affects

TABLE 17-1 Types of Tinea

Tinea	Description
Tinea corporis	Body ringworm; rash that begins as a small area of red, raised spots and papules. The rash slowly becomes ring-shaped, with a red-colored, raised border and a clearer center. The border may look scaly.
Tinea pedis	Athlete's foot; scales and fissures occur on the soles of the feet and between toes; a foul odor usually accompanies lesions
Tinea cruris	Jock itch; red, ringlike areas with vesicles
Tinea capitis	Scalp ringworm; single or multiple patches of hair loss that may have a black dot pattern, inflammation, scaling, pustules, and pruritis
Tinea unguium	Nail fungus; white patches on nails, eventually turn the nail brown; nail thickens and cracks and may be destroyed
Tinea barbae	Barber's itch; deep, inflammatory pustules and crusting around hairs

fingernails. This fungus is difficult to treat because it resides under the nail. The infection begins at the nail tips, causing white patches and eventually turning the nail brown. The nail thickens and cracks. If left untreated, the fungus may destroy the entire nail and tends to spread to other nails (Figure 17-12 ►).



Figure 17-8 ► Tinea corporis, or body ringworm. (Courtesy of the Centers for Disease Control and Prevention/Lucille K. Georg, 1964)

- **Tinea barbae**, or barber's itch, affects bearded areas of the face and neck and is characterized by deep, inflammatory pustules and crusting around hairs (Figure 17-13 ►).

Tinea is usually caused by *Trichophyton rubrum* or *Trichophyton tonsurans*, types of fungus.

Diagnosis of tinea is by visual examination and may include microscopic examination of skin scrapings. Tinea can be treated by cleaning and drying the affected area and using antifungal medications. It can be hard to prevent tinea, but the best way is to wear absorbent, breathable fabrics such as cotton, keep the skin clean and dry, and wear sandals or shoes in gyms, locker rooms, and pools.



Figure 17-9 ► Tinea pedis, or athlete's foot. (Courtesy of the Centers for Disease Control and Prevention/Dr. Lucille K. Georg, 1964)



Figure 17-10 ► Tinea cruris, or jock itch. (© Custom Medical Stock Photo)

Seborrheic Dermatitis Seborrheic dermatitis, also called dandruff, is a chronic inflammatory skin disorder generally affecting areas of the head and trunk where sebaceous glands are prominent. Seborrheic dermatitis of the scalp in infants is known as cradle cap. The worldwide prevalence of seborrheic dermatitis is relatively low, about 3–5%. It is probably underreported, with many people going untreated. Oily skin or hair increases the risk of developing seborrheic dermatitis, and it probably has a hereditary component. Parkinson's disease and reduced



Figure 17-11 ► Tinea capitis, or scalp ringworm. (Courtesy of the Centers for Disease Control and Prevention, 1959)



Figure 17-12 ► Tinea unguium, or nail fungus. (Courtesy of the Centers for Disease Control and Prevention/Dr. Edwin P. Ewing, Jr., 1997)

immunity also place people at risk for developing seborrheic dermatitis.

Signs and symptoms include dry or greasy scaling of the scalp, sometimes with pruritus. Severe disease is marked by yellow or red scaling papules. Infants develop thick, yellow-crusting scalp lesions. The etiology of seborrheic dermatitis is idiopathic, but the yeast *Malassezia* or other fungi that normally inhabit the scalp may play a role. *Malassezia* or other fungi probably induces an inflammatory response in some people. Genetics, overproduction of sebum, and environmental factors may also play a role in seborrheic dermatitis.

Seborrheic dermatitis is recognized and diagnosed easily during a visual examination of the scalp or affected skin. Although no cure exists



Figure 17-13 ► Tinea barbae, or barber's itch. (Courtesy of the Centers for Disease Control and Prevention, 1975)

for seborrheic dermatitis, it can be controlled by frequently cleaning the affected area with soap. Effective treatment includes medicated shampoo, antifungal medication, and corticosteroids to reduce pruritis. Seborrheic dermatitis is not preventable.

Candidiasis Candidiasis is an infection caused by the yeast *Candida albicans*. *C. albicans* can infect the mouth, vagina, skin, stomach, urinary tract and it can cause systemic infections. Up to 14% of immunocompromised patients develop systemic candidiasis, but the overall prevalence of candidiasis is unknown. *Candida* species are normal flora that are usually kept under control by the other normal flora and by the body's immune defenses. Candidiasis occurs when there is an overgrowth of *Candida* under conditions that reduce immunity or disrupt the normal flora. Thus, risk factors include long term treatment with antibiotics and corticosteroids, illness due to immune deficiency and diabetes, and chemotherapy. Hormonal changes disrupt the normal flora, so oral contraceptive use and pregnancy increase the risk for candidiasis. About 75% of women are likely to have at least one vaginal *Candida* infection, and up to 45% have two or more.

Signs and symptoms of vaginal candidiasis may include a white cottage cheese-like discharge from the vagina, accompanied by burning, pruritis, and erythema (Figure 17-14 ►). Creamy white patches on the tongue or side of the mouth characterize a *Candida* infection of the mouth, also known as thrush. The patches are often painful and can easily be scraped off. Thrush is common in young healthy children, immunocompromised adults, and diabetics. *Candida* can cause skin infections (cutaneous candidiasis) in areas of skin that receive little ventilation and are unusually moist. Thus, candidiasis affects the diaper area, the hands of people who routinely wear rubber gloves, the rim of skin at the base of the fingernail, the groin, in the crease of the buttocks, and the skin folds under large breasts. Cutaneous candidiasis causes patches of red, moist, weepy skin, sometimes with small pustules nearby.

Diagnosis of candidiasis requires visual and microscopic examination, and may include a culture. Treatment includes antifungal medications. Candidiasis can be prevented by keeping skin clean and dry, using antibiotics correctly,



Figure 17-14 ► Vaginal candidiasis.

and eating a healthy diet. Diabetics should keep their blood sugar under control because blood pH and sugar can promote growth of *Candida*.

Skin Parasites

Pediculosis **Pediculosis** is an infestation of lice, external parasites that feed on blood. Lice have claws on their legs that are adapted for feeding and clinging to hair or clothing, and they are transmitted from person to person by close physical contact or by sharing combs, clothes, hats, or bed linens. The three types of lice that parasitize humans are *Pediculus humanus capitis* (head louse), *Pediculus humanus corporis* (body louse), and *Phthirus pubis* (pubic louse).

Pediculosis is extremely common, affecting more than 12 million people in the United States each year. Pruritis, the most common symptom of the infestation, is caused by the saliva of lice as they feed on human blood. Scratching makes the skin vulnerable to infection by other microorganisms. The lice bites cause multiple erythematous papules.

Pediculus humanus capitis, or head lice (Figure 17-15 ►), are common among schoolchildren. An estimated 12–24 million days of school are lost each year in the United States because of



A



B

Figure 17-15 ► (A) Female head louse. (Courtesy of the Centers for Disease Control and Prevention/ Dr. Dennis Juranek); (B) Unhatched nit of a head louse. (Courtesy of the Centers for Disease Control and Prevention/Dr. Dennis Juranek)

head lice. Adult head lice are difficult to see, but their nits (eggs) can be located on the hair shaft. The female head louse lays as many as 10 eggs per 24 hours, usually at night. The average lifespan of head lice is 30 days, but they rely on human blood for survival, so a female louse cannot survive for more than 3 days off the human head.

Pthirus pubis, or pubic lice (Figure 17-16 ►), infest pubic hair of both men and women and are generally spread by sexual contact. The lice do not spread other sexually transmitted infections. The pubic louse gets the nickname of “crab” from its shorter, broader body and large front claws, which give it a crablike appearance. Their large claws enable pubic lice to grasp the coarser



Figure 17-16 ► Pubic louse. (World Health Organization)

pubic hairs in the groin, anal, and armpit areas. The female pubic louse reproduces much more slowly than the head louse, laying only one to two eggs per day. The average life cycle of pubic lice is 35 days, and because they also rely on human blood, these lice cannot survive away from the human host for more than 1 day.

Pediculus humanus corporis, or body lice (Figure 17-17 ►), can spread serious disease. The body louse is the vector of typhus, trench fever, and relapsing fever. Unlike the head louse and the pubic louse, the body louse lives in human clothing, crawling onto the body only to feed, usually at night. Body lice lay 10–15 eggs per day on the fibers of clothing, mainly close to the seams. The adult female body louse, unlike the head louse, can survive as long as 10 days away from the human body without a blood meal.

A diagnosis of any type of pediculosis requires the finding of live specimens of lice or a viable nit. Treatment includes use of pediculicide medications. Washing fomites in temperatures exceeding 131°F (55°C) for more than 5 minutes and machine drying kills nits and lice. Items that cannot be washed in hot water should be dry-cleaned or sealed in a plastic bag for 5 days. Prevention includes proper hygiene and avoiding contact with infected individuals.

Scabies **Scabies**, commonly called “the itch,” is caused by a contagious parasitic mite called *Sarcoptes scabiei* and is associated with poor living

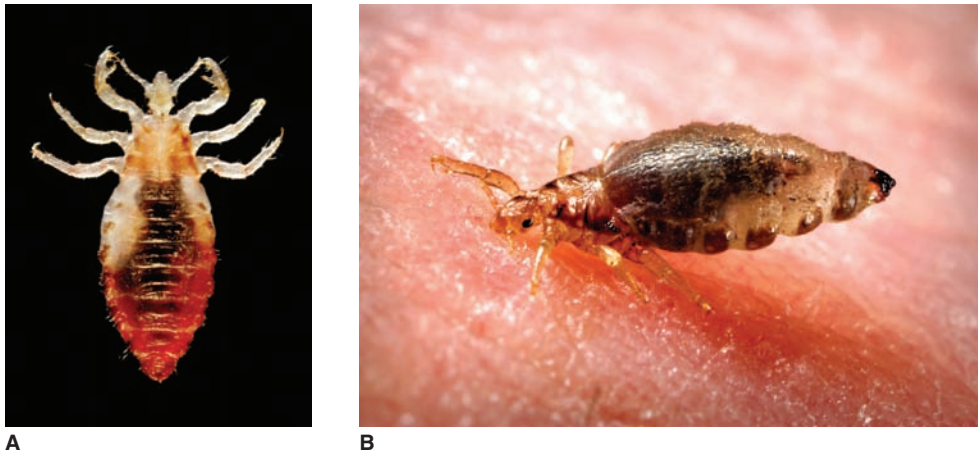


Figure 17-17 ► (A) Male body louse. (Courtesy of the Centers for Disease Control and Prevention/Frank Collins, Ph.D. Photo credit: James Gathany) (B) Female body louse obtaining a blood meal. (Courtesy of the Centers for Disease Control and Prevention/Frank Collins, Ph.D. Photo credit: James Gathany)

conditions. Scabies is common worldwide, affecting an estimated 300 million people annually. Scabies occurs among the homeless and in overcrowded conditions. Scabies can be transmitted through any close physical contact with someone who has scabies. Mites are unable to fly or jump, so transmission is predominantly through direct skin-to-skin contact. Indirect contact through fomites such as infested bedding or clothing is not common.

Scabies mites can survive up to 4 days off the human body. When it contacts skin, the female mite burrows into skin folds in the groin, under the breasts, and between fingers and toes. As she burrows, she lays eggs in the tunnels, the eggs hatch, and the cycle starts again. Intense pruritus is caused by a type IV hypersensitivity reaction to the mite. Vesicles and pustules develop, and the tunnels in the skin appear as grayish lines (Figure 17-18 ►). Scratching opens the lesions to secondary bacterial infection.

Scabies is diagnosed by visual examination and microscopic examination of skin scrapings. Treatment includes use of scabicide medication. Pruritus may persist while treatment is being administered. Washing clothes and bedding in temperatures exceeding 131°F (55°C) for more than 5 minutes and machine drying kills scabies mites and their eggs. Items that cannot be washed in hot water should be dry-cleaned or sealed in a plastic bag for 5 days. Scabies can be

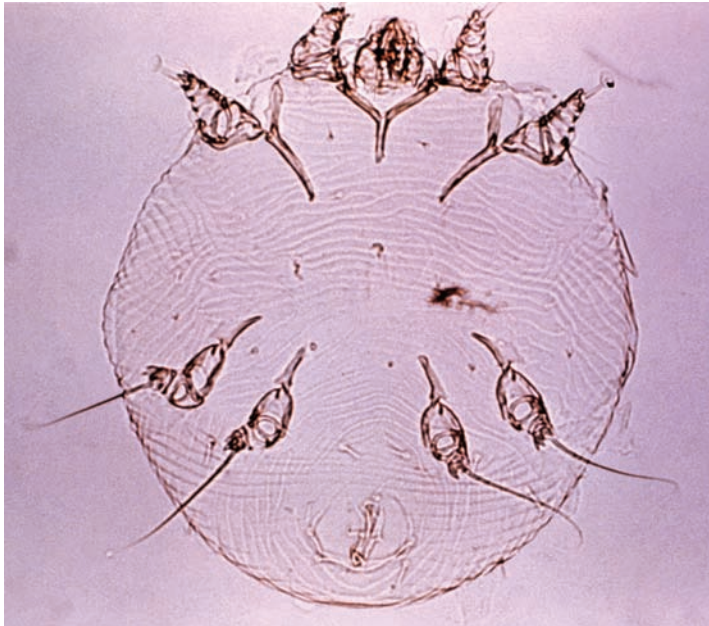
prevented with good hygiene and avoiding contact with infected individuals.

Hypersensitivity or Immune Disorders of the Skin

Allergic or hypersensitivity reactions are easily observed in the skin. This serves as a basis for the patch tests given to determine specific allergies. Some diseases of the skin develop in people with a genetic predisposition to allergies. Others occur in anyone who has been sensitized to an allergen, such as poison ivy. For more information, refer to the chapter on immunity.

Urticaria (Hives)

Urticaria, or hives, results from a vascular reaction of the skin to an allergen. Urticaria is a common skin condition that affects up to 20% of the population at some point in their lives. Having an allergy or family members with urticaria increases the risk of developing urticaria. The lesions are smooth, slightly elevated wheals (patches), with red edges and pale centers that appear suddenly (Figure 17-19 ►). Wheals usually appear first on the covered areas of the skin such as the trunk and upper parts of the arms and legs and appear in batches. Each wheal may last from a few minutes up to 6 hours. Urticaria is accompanied by intense pruritus.



A



B

Figure 17-18 ► (A) *Sarcoptes scabiei* (CDC/Donated by the World Health Organization/Geneva, Switzerland) (B) *Sarcoptes scabiei* infestation. (Centers for Disease Control and Prevention/Susan Lindsley)

At least half of the time, the etiology of urticaria cannot be determined. The most common triggers are:

- Allergies to food, medications, cosmetics, soap, and detergent
- Viral infections
- Insect stings and bites
- Transfusion of blood or blood products
- Emotional and physical stress
- Physical agents such as sunlight, heat, cold, water, and pressure

Visual examination and a medical history permit diagnosis and identification of possible causes. Treatment is aimed at reducing inflammation and signs and symptoms. Corticosteroids decrease inflammation, antihistamines control pruritus, and topically applied calamine lotion relieves pruritus. If the cause of the allergic reaction can be determined, the allergen should be avoided. Reducing emotional and physical stress may also help.

Dermatitis

Dermatitis is a broad term covering many different disorders characterized by a rash accompanied by pruritus and erythema.

Allergic contact dermatitis is a localized inflammation of the skin caused by contact with an allergen. The prevalence is not known, because many cases are mild or go unreported to doctors.



Figure 17-19 ► Urticaria on trunk. (© Wellcome Image Library/Custom Medical Stock Photo. All rights reserved.)

Family history or prior allergic reactions to plants, chemicals, cleaners, and metals increase the risk for developing contact dermatitis. Initial exposure to an allergen does not cause a reaction, but it does sensitize the skin so that it will react to the next exposure. The allergic reaction is usually confined to the area where the allergen touched the skin. A rash accompanied by erythema is the usual reaction, but sometimes the rash does not appear for 1–2 days after the exposure (Figure 17–20 ►). Pruritus and burning may accompany the rash.

Allergic contact dermatitis can be caused by many substances that act as allergens:

- Poison ivy, poison oak, and poison sumac
- Hair products
- Metal nickel (jewelry and belt buckles)
- Tanning agents in leather
- Latex
- Citrus fruit peel
- Fragrances in soaps, shampoos, lotions, perfumes, and cosmetics
- Topical medications

Allergic contact dermatitis is diagnosed by visual observation of the skin rash. Treatment is aimed at reducing inflammation and relieving symptoms. Corticosteroids reduce inflammation, and antihistamines decrease pruritus. Allergic contact dermatitis can be prevented by avoiding contact with the allergen. If contact does occur, the allergen should be washed off immediately with soap and water. If exposure cannot be easily avoided, gloves and protective clothing may be helpful. Barrier creams are also available that



Figure 17–20 ► Allergic contact dermatitis. (Courtesy of the Centers for Disease Control and Prevention/Richard S. Hibbits)

can block certain substances, such as poison ivy, from contacting the skin.

Atopic dermatitis is the most common type of eczema, a chronic skin disease that is frequently associated with other allergic conditions such as asthma and hay fever. Atopic dermatitis is common, affecting 10–15% of the population in the United States. It occurs especially among people with a family or personal history of allergic disease. Others at risk include infants and young children and people exposed to skin irritants and extremes in temperature. Atopic dermatitis appears as irritated, red, dry, crusted patches on the skin and usually causes pruritus (Figure 17–21 ►). If the skin becomes infected, the affected areas may ooze fluid. Scratching causes more irritation and increases the risk of infection.

In babies, atopic dermatitis primarily affects the face, neck, ears, and torso. It also appears on the tops of feet or the outside of the elbows. Atopic dermatitis in older children, teenagers, and adults usually involves the skin inside the creases of the inward bend of the elbow, as well as the knee, ankle or wrist joints, hands, and upper eyelids.

The etiology of atopic dermatitis is idiopathic, but people who have it usually have many allergic disorders, particularly asthma, hay fever, and food allergies. The relationship between atopic dermatitis and these disorders is not clear because atopic dermatitis is not an allergy to a particular substance. Many conditions can make atopic dermatitis worse, including emotional stress, changes in temperature or humidity, bacterial skin infections, and contact with



Figure 17–21 ► Atopic dermatitis. (Courtesy of the Centers for Disease Control and Prevention)

irritating clothing. In some infants, food allergies may provoke atopic dermatitis.

Atopic dermatitis is diagnosed by visual examination of the skin reaction. Although it cannot be cured, treatment can reduce inflammation and relieve the symptoms. Corticosteroids can reduce inflammation and immunomodulators decrease T-cell activation. Because the triggers are often unknown atopic dermatitis is not easily prevented.

Rosacea

Rosacea is an inflammatory skin disorder that causes facial erythema. According to the National Rosacea Society, rosacea affects more than 16 million people in the United States. Those at risk for developing rosacea are middle-aged, have fair skin, and have a family history of rosacea. Women are at higher risk but men get more severe rosacea.

The primary signs of rosacea include flushing, persistent erythema, papules and pustules, and telangiectasias (tiny blood vessels dilate and become more visible through the skin) (Figure 17-22 ►). Left untreated, rosacea progresses and becomes more severe over time. In most people rosacea is cyclic, alternating between mild and severe symptoms. In severe cases the nose may grow swollen and bumpy from excess tissue. This condition, called rhinophyma, gave the late comedian W.C. Fields his



Figure 17-22 ► Rosacea.

trademark bulbous nose. Rhinophyma occurs mainly in men. In approximately 60% of people who have rosacea the eyes are also affected. Ocular rosacea is characterized by burning and grittiness and watery, itchy, bloodshot eyes. If not treated this serious complication, known as rosacea keratitis, can damage the cornea and impair vision.

The etiology of rosacea is idiopathic. A number of factors can trigger or aggravate rosacea by increasing blood flow to the surface of the skin. Some of these include hot foods or beverages, spicy foods, alcohol, temperature extremes, sunlight, stress, anger or embarrassment, strenuous exercise, wind, hot baths or saunas, some skin care products, and drugs that dilate blood vessels.

Rosacea is diagnosed by visual examination. Unfortunately, rosacea is incurable. The first step in treatment and prevention is avoidance of rosacea triggers. Treatment may include medications to decrease inflammation including antibiotics and vitamin A derivatives. Telangiectasias can be treated with laser surgery.

Psoriasis

Psoriasis is a chronic skin disease characterized by scaling and inflammation. According to the National Psoriasis Foundation, psoriasis affects an estimated 7.5 million people in the United States. Risk factors for psoriasis include a family history of psoriasis, stress, smoking, obesity, HIV infection, and recurring streptococcal infections.

Of the many forms of psoriasis, plaque psoriasis accounts for 80% of cases. Typically found on the elbows, knees, scalp, and lower back, plaque psoriasis is characterized by raised, inflamed, red lesions covered by a silvery white scale (Figure 17-23 ►). Plaque psoriasis may worsen and improve and then worsen again. The etiology of plaque psoriasis is idiopathic but may involve genetics, the immune system, and environmental triggers. Possible environmental triggers include stress, anxiety, injury to the skin, cold and dry climate, and medications such as nonsteroidal anti-inflammatory medication, beta-blockers, and lithium.

Psoriasis is diagnosed by visual examination and may require biopsy to rule out other



Figure 17–23 ► Plaque psoriasis (Courtesy of the Centers for Disease Control and Prevention/Dr. N.J. Fiumara, 1976)

skin diseases. Although incurable, psoriasis can be treated to reduce outbreaks and symptoms. Salicylic acid encourages the sloughing of dead, scaling skin cells. Corticosteroids reduce inflammation and pruritis, and antiproliferatives decrease mitosis of skin cells. Phototherapy, exposing the skin to ultraviolet light on a regular basis under medical supervision, is generally used for patients with moderate to severe psoriasis who are not responding to topical treatments or who have disease too extensive for topical treatment. Phototherapy decreases mitosis, scaling, and inflammation. If moderate to severe psoriasis does not respond to topical treatment or phototherapy, systemic treatment may be necessary. Systemic therapy may include vitamin A derivatives to decrease mitosis, immunosuppressants to decrease T-cell activation and proliferation, and immunomodulators to reduce inflammation. Other treatments may include monoclonal antibodies that reduce inflammation and genetically engineered immunosuppressive drugs that decrease the activity and number of T cells. Psoriasis is not preventable.

Benign Tumors of Skin

Nevus (Mole)

A **nevus** is a small, dark skin growth that develops from melanocytes growing in clusters. It is unknown why nevi develop. Most adults have between 10 and 40 nevi, and there are no known risk factors for developing nevi. Although the

typical nevus is a plain, brown spot, nevi come in a wide variety of colors, shapes, and sizes.

The nevi are usually harmless, but some become malignant. A dysplastic nevus, also called an atypical mole, is generally larger than common nevi and has an irregular border. Atypical moles are more likely than other moles to develop into melanoma, but most do not become malignant. Nevi should be examined by a physician if they are painful, itching or burning, oozing or bleeding, inflamed, scaly or crusty, or suddenly different in size, shape, color, or elevation. Diagnosis of nevi is by visual examination and may include a biopsy. Nevi can be removed by excision or cryosurgery. There is no way to prevent nevi, but the best way to catch potential problems at an early stage is to become familiar with the location and pattern of the nevi. Skin should be examined carefully on a regular basis.

Prevention PLUS!

Examining Your Skin

A monthly skin self-exam helps find any suspicious skin problems early. Check your skin in a room with plenty of light. Use a full-length mirror and a handheld mirror. Make note of where your birthmarks, moles, and other skin marks are. During your head-to-toe skin self-exam, you will be looking for new moles; moles that have changed in size, texture, color, or shape; moles or sores that continue to bleed or won't heal; or a mole or skin growth that looks very different from other skin growths.

Follow these step-by-step instructions to examine your skin:

- Look at your face, neck, ears, and scalp. You may want to use a comb or blow dryer to move your hair so that you can see better.
- Look at the front and back of your body in the mirror. Raise your arms and look at your left and right sides.
- Bend your elbows. Examine your fingernails, palms, forearms, and upper arms.
- Examine the front, back, and sides of your legs. Look at your genital area, buttocks, and between your buttocks.
- Sit down and examine your feet, including your toenails, soles, and spaces between your toes.

Think Critically

1. How often should you examine your skin?
2. What part(s) of your skin should you examine?

Hemangioma

Hemangioma is a benign tumor made of small blood vessels that form a red or purple birthmark. Hemangiomas are present in 4–5% of newborns. Risk factors for hemangiomas include being female, low birth weight, and being Caucasian. Of hemangiomas, about 30% are visible at birth and the rest become visible within 1–4 weeks of birth. More than 80% of hemangiomas occur on the head or neck. Several types of hemangiomas occur:

- Port-wine stain is a dark red to purple birthmark that occurs in 3 of every 1,000 infants and is usually visible at birth (Figure 17–24 ►). Port-wine stain can be flat or slightly raised, is usually permanent, and can appear anywhere on the body but usually appears on the face, neck, scalp, arms, or legs.
- Strawberry hemangioma is a strawberry red, rough, protruding lesion on the face, neck, or trunk and is seen in approximately 0.5% of infants (Figure 17–25 ►). Strawberry hemangiomas are the most common type, accounting for 65% of hemangiomas. The tumor may be present at birth or a few



Figure 17–24 ► Port-wine hemangioma. (© Custom Medical Stock Photo)



Figure 17–25 ► Strawberry hemangioma. (© NMSB/Custom Medical Stock Photo)

weeks after birth. Strawberry hemangioma will grow, start to fade, and turn gray, usually disappearing between the ages of 5 and 10.

- Cherry hemangioma is a small, red, dome-shaped tumor that appears most frequently after age 40 and occurs in more than 70% of people age 70 or older. Cherry hemangiomas appear nearly anywhere on the skin, but most commonly on the torso, with many about the size of a pinhead. Some grow to one-quarter inch across or more and become spongy and dome-shaped.

The etiology of hemangioma is idiopathic. In many cases treatment is not needed. Treatment may include laser therapy to reduce color of the hemangioma and improve skin texture, corticosteroids to control or stop the growth of the hemangioma, and surgical excision. Because hemangiomas develop before birth, they are not preventable.

Skin Cancer

Skin cancer is the most common of all cancers. About one in five people in the United States will develop skin cancer in their lifetime. Risk factors

for skin cancer include UV radiation exposure, having skin that burns easily, severe blistering sunburns, lifetime sun exposure, tanning, exposure to artificial sources of UV radiation (tanning booths, sunlamps), a personal or family history of skin cancer, and taking certain medications that increase sensitivity to UV radiation (some antibiotics, hormones, antidepressants). Additional risk factors for specific skin cancers will be listed in the following sections.

Nonmelanoma Skin Cancer

The American Cancer Society (ACS) estimates that there are 2.2 million cases of nonmelanoma skin cancer and 2,000 people will die from nonmelanoma skin cancer every year in the United States. The exact numbers are not known because nonmelanoma skin cancers are not reported to cancer registries. The main risk factors for nonmelanoma skin cancer include sun exposure; having old scars, burns, ulcers, or areas of inflammation on the skin; exposure to arsenic at work; and having radiation therapy.

The most common skin cancer is **basal cell carcinoma** (BCC), a slow-growing and generally nonmetastasizing tumor. Approximately 8 out of 10 skin cancers are BCC. BCC begins in the lowest layer of the epidermis and usually develops on UV radiation-exposed areas, especially the head and neck. The lesion begins as a pearly nodule with rolled edges that may bleed and form a crust (Figure 17-26 ►). Ulceration occurs and size increases if BCC is not treated.

Squamous cell carcinoma (SCC) is the second most common form of skin cancer. SCC develops in any squamous epithelium of the body, including the skin or mucous membranes lining natural body openings; SCC are most common in areas frequently exposed to UV radiation, such as the rim of the ear, lower lip, face, bald scalp, neck, hands, arms, and legs. Additional risk factors for SCC include having actinic keratosis and infection with certain strains of the human papillomavirus. The lesion is a crusted nodule that ulcerates and bleeds (Figure 17-27 ►).

UV radiation-induced damage to DNA is the cause of nonmelanoma skin cancer. Diagnosis requires visual examination and skin biopsy to determine the nature of the cellular changes in the tumor. Often BCC and SCC are completely



Figure 17-26 ► Basal cell carcinoma. (© Caliendo/Custom Medical Stock Photo)

cured by surgical removal of the tumor. Other treatment options may include radiation therapy and photodynamic therapy. In photodynamic therapy a photosensitizing agent is applied to the tumor and is taken up by the cancer cells. The medication is activated by light destroying the cancer cells. Additional treatments include chemotherapy drugs and immunomodulators to stimulate the immune system. A drug was approved by the Food and Drug Administration (FDA) in 2012 to treat BCC that has



Figure 17-27 ► Squamous cell carcinoma.

metastasized, come back after surgery, or cannot be treated with surgery or radiation therapy. The drug blocks a defective biological signaling pathway that results in abnormal cell growth. The best way to prevent nonmelanoma skin cancer is to limit exposure to UV radiation. Examining the skin on a regular basis can help find cancer early.

Melanoma

Melanoma is cancer that begins in the melanocytes. Because melanocytes produce melanin, melanoma tumors are often brown or black. The ACS estimates that in 2013 approximately 76,690 cases of melanoma will be diagnosed and 9,480 people will die from melanoma in the United States. According to the World Health Organization (WHO), in 2008, 101,807 people were diagnosed with melanoma and 25,860 died of melanoma worldwide. The average age of diagnosis is 60. Risk factors for melanoma include having an atypical mole, and having more than 50 common nevi. Often the first sign of melanoma is a change in the shape, color, size, or feel of an existing mole (Figure 17-28 ►). Melanoma may also appear as a new mole.

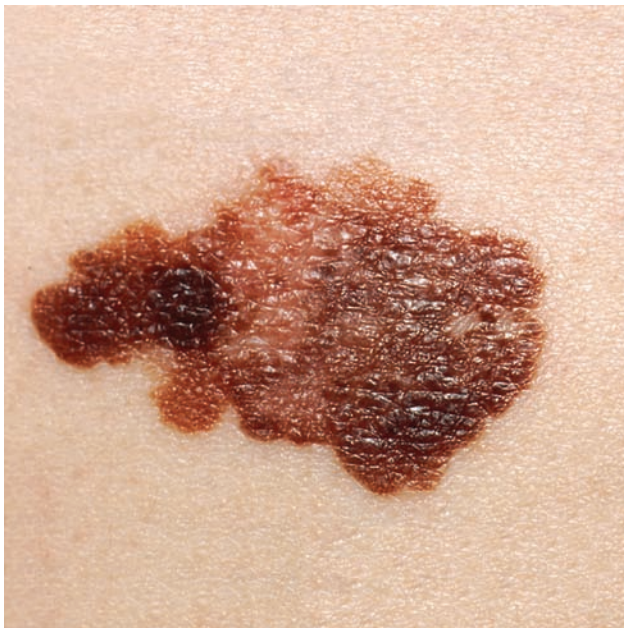


Figure 17-28 ► Malignant melanoma. (National Cancer Institute)

Thinking of "ABCDE" can help you remember what to look for:

- **Asymmetry:** The shape of one half does not match the other half.
- **Border that is irregular:** The edges are often ragged, notched, or blurred in outline. The pigment may spread into the surrounding skin.
- **Color that is uneven:** Shades of black, brown, and tan may be present. Areas of white, gray, red, pink, or blue may also be seen.
- **Diameter:** There is a change in size, usually an increase. Melanomas can be tiny, but most are larger than the size of a pea (larger than 6 millimeters or about 1/4 inch).
- **Evolving:** The mole has changed over the past few weeks or months.

Some melanomas show all of the ABCDE features; others show changes in only one or

Prevention PLUS!

Skin Cancer Prevention Tips

- Use sunscreen year round with a sun protection factor (SPF) of at least 15 and both UVA and UVB protection. Apply about one ounce of sunscreen (about the size of a ping-pong ball) 30 minutes before going outside. Once you're outside reapply sunscreen every 2 hours or more often if you are swimming or sweating.
- Avoid sun exposure during the middle of the day; the sun's rays are strongest between the hours of 10:00 A.M. and 2:00 P.M.
- Wear clothing to protect exposed skin.
- Wear a hat with a wide brim to shade your face, head, ears, and neck.
- Wear sunglasses.
- Avoid indoor tanning.
- See your physician every year for a professional skin exam.
- Check your skin for signs of skin cancer.

Think Critically

1. What is the most important way to lower your risk for skin cancer?
2. How often should you see your physician for a professional skin exam?

two of the ABCDE features. In more advanced melanoma, the texture of the mole may change and the skin on the surface may look scraped, and the surface may ooze or bleed. Occasionally melanoma is itchy, tender, or painful.

UV radiation–induced damage of DNA causes melanoma. Diagnosis of melanoma requires visual examination, history, and biopsy of the tumor. If the cancer has spread, imaging tests may be used to aid in staging the cancer. The earlier the cancer is found, the better are the chances for survival and recovery. The 5-year survival by stage of disease are localized disease, 98.1%; regional disease, 61.4%; and metastatic disease, 15.3%. Treatment may include surgery, chemotherapy, radiation therapy, immunotherapy, and targeted therapy.

Sebaceous Gland Disorders

Acne

Acne is a skin disorder that consists of pimples, cysts, nodules, and plugged pores that occur on the face, neck, chest, back, shoulders, and upper arms. Acne is the most common skin disorder in the United States, affecting 40–50 million people. Family history increases the risk for developing acne. Acne is also associated with the hormonal changes that occur during adolescence, pregnancy, and menstruation. The use of corticosteroids, androgens, and lithium also increase the risk for developing acne.

There are two types of acne: noninflammatory and inflammatory. Acne is caused by three major factors: overproduction of sebum by sebaceous glands, blockage of the hair follicles that release sebum, and growth of the bacterium *Propionibacterium acnes* within the hair follicles. Acne develops when old skin cells are not shed and clump, forming a plug (comedo) that traps oil and bacteria inside the hair follicle. Noninflammatory acne includes closed comedones (whiteheads) and open comedones (blackheads). If there is a break in the follicle wall (forming a papule), inflammation is triggered and inflammatory acne develops. Pustules form as white blood cells make their way to the surface of the skin. If the hair follicle totally collapses, a nodule is formed. Severe chronic acne can lead to disfigurement and scarring (Figure 17–29 ►).



Figure 17–29 ► Severe acne. (© Custom Medical Stock Photo)

Acne is diagnosed by visual inspection of the skin. Treatment for acne includes vitamin A derivatives to unclog pores and decrease inflammation. Antibiotics kill bacteria and reduce inflammation. Benzoyl peroxide is an antibacterial oxidizing agent that inhibits the growth of *P. acnes*. Hormone therapy (oral contraceptives) may be used as an anti-androgen to decrease sebum production. Often, a combination of treatments is required to achieve optimal results. The vitamin isotretinoin is used to treat severe acne or acne that does not respond to other treatments. Isotretinoin is associated with severe birth defects if pregnancy occurs during the course of treatment or within several weeks of concluding treatment.

Acne is not easily prevented, but its signs and symptoms can be controlled. The number and severity of acne outbreaks may be reduced by not overcleansing the skin, not using harsh scrubs, avoiding products with high concentrations of alcohol, using skin care products and makeup that is noncomedogenic, and keeping hands away from the face.

Pigment Disorders

The main skin pigment, melanin, is interspersed among other cells in the epidermis. Skin color varies from light to dark depending on the number of melanocytes present. Melanin production normally increases with exposure to UV radiation, causing tanning. Hypopigmentation is caused by an abnormally low amount or absence of melanin. Hypopigmented skin may

be pale white to various shades of pink due to blood vessels beneath the skin. Hyperpigmentation is caused by an abnormally high amount of melanin.

Albinism

Albinism is a hereditary disorder characterized by the absence of melanin. Albinism affects people of all races. Nearly 1 in 17,000 people in the United States has some type of albinism, and 1 in 70 carries albinism genes. Because albinism is a hereditary disease, the risk factors include being a child of a parent with albinism or being a child of a parent who is a carrier of albinism. People with albinism have visual abnormalities, including rapid eye movements, eyes that do not track properly, photophobia, decreased visual acuity, or even functional blindness.

Ocular albinism affects only the eyes. People with ocular albinism usually have normal or only slightly lighter than normal skin. However, examination of the eye will show that there is no pigment in the retina. Ocular albinism is X-linked recessive.

Oculocutaneous albinism affects both the skin and the eyes. Common signs of oculocutaneous albinism include absence of pigment from the hair, skin, or irises of eyes. Oculocutaneous albinism is autosomal recessive.

Albinism may be diagnosed based on the appearance of the skin, hair, and eyes and genetic testing. Treatment includes improving vision, protecting eyes from bright light, and protecting the skin and eyes from the sun. There is no way to prevent albinism.

Vitiligo

Vitiligo is a loss of melanin resulting in white patches of skin. Vitiligo is a rare condition that occurs in 0.5–1% of the population of the United States. It affects men and women of all races but is often more noticeable and more disfiguring in people with darker skin. Risk factors for vitiligo include a family history of vitiligo, premature graying of the hair, age (10–30), and having certain autoimmune diseases (Addison's disease, hyperthyroidism, pernicious anemia). Although any part of the body may be affected by vitiligo, depigmentation usually develops first

on sun-exposed areas of the skin. Vitiligo usually starts as small areas of pigment loss that spread and become larger with time. The white patches are usually well demarcated and may cover large parts of the body (Figure 17–30 ►).

Diagnosis is by visual inspection of the skin. The cause is idiopathic and there is no cure. Small areas of skin may be covered with tinted makeup, and sunscreen should always be applied to the skin to prevent sunburn. Treatment options include repigmentation agents, ultraviolet light therapy, depigmentation agents, and surgery to transplant the patient's normal melanocytes into areas of vitiligo. Vitiligo is inherited and therefore not preventable.

Ephelides and Lentigines

Ephelides is a skin condition also known as macule or freckles that occurs most often in people with light complexions. Ephelides are predominately found on the face, although they may appear on any skin exposed to the sun. Ephelides are flat spots that are red or light brown. Ephelides are genetic and are related to the presence of the melanocortin-1 receptor gene variant, which is dominant. Ephelides can also be triggered by long exposure to UV radiation. Treatment is not necessary and freckles certainly cannot be prevented. The regular use of sunscreen helps suppress the appearance of ephelides.



Figure 17–30 ► Vitiligo. (© Custom Medical Stock Photo)

Lentigines are a type of freckle that develop in older adults and are often called liver spots or age spots. The only known risk factor for lentigines is exposure to the sun. Lentigines are small, brown lesions occurring on the face, neck, and back of the hands (Figure 17–31 ►). Lentigines are not due to aging but are due to excessive sun exposure. Lentigines are benign so treatment is not necessary. If a patient requires treatment because the age spots are disfiguring or embarrassing, treatment may include depigmentation agents, vitamin A derivatives, chemical peels, cryosurgery, and laser treatment. Protecting the skin from sunlight is the best way to prevent lentigines.

Melasma

Melasma, also known as chloasma or pregnancy mask, is characterized by patches of darker skin on the face, especially over the cheeks. The prevalence of melasma is estimated to occur in 5–6 million women in the United States. The etiology of melasma is idiopathic but is believed to be due to an increase in the production of melanin. What causes the increased production of melanin is not known. Possible triggers include hormones, prolonged sun exposure, use of oral contraceptives, and certain medications (tetracycline, antimalarial drugs). Treatment may include corticosteroids, depigmentation agents, vitamin A derivatives, chemical peels, or laser treatment. Protecting skin from the sun is critical to preventing melasma.



Figure 17–31 ► Lentigo. (© Zuber/Custom Medical Stock Photo)

Skin Trauma and Injury

Lacerations are cuts in the skin caused by a sharp object. Abrasions, or scrapes, result from wearing away the upper layer of skin by friction, leaving red, raw, and painful injuries with minimal bleeding. Punctures are injuries caused by a pointed object piercing or penetrating the skin, with minimal bleeding. A possible complication of puncture is tetanus. Punctures create an anaerobic environment preferred by the tetanus bacteria. Sutures or glue may be needed to close skin that has been split open or is gaping.

Contusions, or bruises, are caused when blood vessels are damaged or broken as a result of a blow to the skin. Blood leaks out of the damaged vessels into the surrounding tissues. A purplish, flat bruise that occurs when blood leaks out into the top layers of skin is known as an ecchymosis. In an avulsion, a portion of the skin has been torn away or is barely attached. Crushing injuries result when a body part is subjected to a high degree of force or pressure, usually after being squeezed between two heavy objects. Hemorrhage, contusions, lacerations, and fractures are possible complications of a crushing injury.

Pressure Ulcers

Pressure ulcers are an area of skin that breaks down when constant pressure is placed against it. Pressure ulcers form in an area of unrelieved pressure, usually over a bony prominence, which reduces blood supply to that area, causing death of cells and tissue. Two-thirds of pressure ulcers occur in patients older than 70 years. The prevalence in nursing homes is estimated to be 17–28%. Pressure ulcers affect immobile people of all ages, the chronically ill, the neurologically impaired, and are the direct cause of death in 7–8% of all paraplegics.

The buttock region is the most common area for pressure ulcers to develop, accounting for more than 70% of all pressure ulcers. The lower extremities account for an additional 15%. The remaining ulcers occur in any location that experiences long periods of uninterrupted pressure.

Risk factors for pressure ulcers include impaired mobility, age, reduced sensory perception, weight loss, poor nutrition and dehydration, urinary or fecal incontinence, excessive moisture or dryness of the skin, medical conditions that

decrease circulation, smoking, decreased mental awareness, and muscle spasms. At-risk patients can develop a pressure sore within 2–6 hours of the onset of pressure. The National Pressure Ulcer Advisory Panel uses a six-stage system to categorize pressure ulcers (see Table 17–2 ►).

As already noted, pressure ulcers are caused by sustained pressure. They are also caused by friction (skin dragged across a surface) and shear (bone moves down, skin over bone stays in place). Figure 17–32 ► shows a patient with several pressure ulcers.

Diagnosis requires a visual examination of the skin and may require a culture and blood tests to assess nutritional status and overall health (complete blood count, lipids, comprehensive metabolic panel, albumin, total protein).

The first step in treatment is eliminating the pressure. Specialized support surfaces and pressure reduction devices have been shown to reduce pressure. Regardless of support surface or device, turning and repositioning the patient remain the cornerstones of prevention and treatment. This should be performed every 2 hours, even in the presence of a specialty surface or bed. Treatment may also include wound debridement, antibiotics if needed, pain management, a healthy diet, muscle spasm relief, and meticulous wound care. Prevention of pressure ulcers



Figure 17–32 ► Pressure sores. (© Caliendo/Custom Medical Stock Photo)

includes repositioning, protecting and monitoring the condition of skin, proper nutrition, and not using tobacco.

Corns and Calluses

Corns and calluses are areas of the skin that have grown thick in response to repeated pressure and friction and form to protect the skin. Bunions, hammertoes, or other foot deformities and manual labor increase the risk for developing corns and calluses.

TABLE 17–2 Pressure Ulcer Stages	
Suspected deep tissue injury	Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer, or cooler as compared to adjacent tissue.
Stage I	Intact skin with nonblanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area.
Stage II	Partial-thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed without slough. May also present as an intact or open/ruptured serum-filled blister.
Stage III	Full-thickness tissue loss. Subcutaneous fat may be visible but bone, tendon, or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunneling.
Stage IV	Full-thickness tissue loss with exposed bone, tendon, or muscle. Slough or eschar may be present on some parts of the wound bed. Often includes undermining and tunneling.
Unstageable	Full-thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green, or brown) and/or eschar (tan, brown, or black) in the wound bed.

A callus (tyloma) involves a thickening of skin without distinct borders. Calluses usually form on feet and hands over bony prominences. Calluses vary in color from white to gray-yellow, brown, or red. Calluses may be painless or tender and may throb or burn. When a callus develops a mass of dead cells in its center (glassy core), it becomes a corn (heloma). Corns have distinct borders and usually form on the feet. Corns may be hard or soft and are usually painful.

The causes of calluses and corns include ill-fitting shoes or socks, not wearing shoes or socks, manual labor, bony prominences on the feet, and biomechanical or gait abnormalities. Diagnosis is by visual examination and may include x-rays to determine underlying bone deformities. Treatment may include shaving or cutting off the hardened area on the skin, removing the corn or callus by medication or surgery, or surgically removing areas of protruding bone where corns and calluses form. Prevention includes wearing gloves to protect hands, making sure shoes and socks fit properly, surgically correcting bony abnormalities, and keeping hands and feet moisturized.

Burns

A burn is damage to the body's tissues caused by heat, chemicals, electricity, sunlight, or radiation. Thermal (heat-caused) burns are the most common. In response to a burn, fluid leaks out of blood vessels into the tissues, causing edema and pain. In addition, damaged skin and other body surfaces become easily infected because they can no longer act as a barrier against invading organisms. The American Burn Association estimates each year in the United States 450,000 people seek medical attention for burns, and burns lead to 45,000 hospitalizations and 3,500 deaths. Risk factors for burns include careless smoking, absent or nonfunctioning smoke detectors, age (children under 4), gender (males are twice as likely to suffer burn injuries), use of wood stoves, exposed heating sources or electrical cords, unsafe storage of flammable or caustic materials, water heaters set above 120°F, substandard or older housing, and substance abuse.

The extent of damage from a burn depends on surface temperature and contact duration. Burns are classified according to the depth of

skin involved. First-degree or superficial burns affect the epidermis; the epidermis is red, swollen, and painful (Figure 17-33 ►). First-degree burns heal in approximately 1 week and do not scar.

Second-degree burns affect the epidermis and portions of the dermis. The epidermis is extremely red and blistered, and the area is very painful (Figure 17-34 ►). Second-degree burns heal in a few weeks; some scarring and depigmentation may occur. Treatment includes antibiotic cream and pain relievers.

Third-degree burns affect the epidermis, dermis, and subcutaneous tissue. The skin may appear white or brown with a dry, leathery appearance (Figure 17-35 ►). The nerve endings are destroyed, so the burned area will not be painful (although the edges where the burn is less deep will be painful). Fluid loss may cause shock. Treatment may include antibiotics, IV fluids, pain relievers, surgical debridement, and grafting. Severe third-degree burns cause extensive scarring.

Fourth-degree burns affect the epidermis, dermis, subcutaneous tissue, and structures below the skin (tendons, bone, ligaments, muscles). Fourth-degree burns are black and charred with eschar. The nerve endings are destroyed, so the burned area itself will not be painful. Fourth-degree burns always require surgery or grafting to close the wounds or amputation, often result in permanent disability, and may require lengthy rehabilitation.



Figure 17-33 ► First-degree burn.

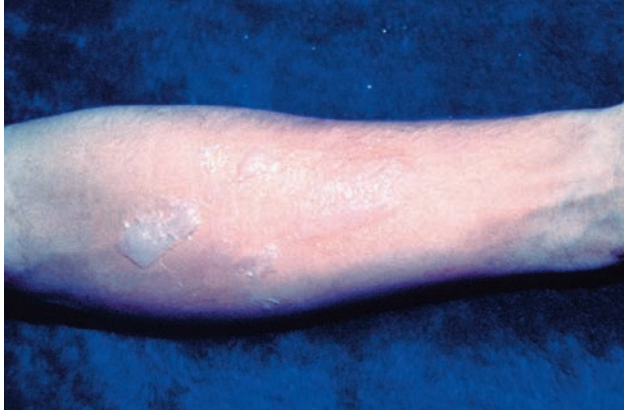


Figure 17-34 ► Second-degree burn.

Burns can be prevented by avoiding exposure to excessive heat, radiation, sunlight, chemicals, and electricity. To determine the severity of a burn, doctors estimate the percentage of the body's surface that has been burned. For adults, doctors use the rule of nines. This method divides almost all of the body into sections of 9% or 18% (Figure 17-36 ►). Burns that involve more than 90% of the body surface, or more than 60% in an older person, usually are fatal. For children, doctors use charts that adjust these percentages according to the child's age (Lund-Browder charts; review Figure 17-36). Adjustment is needed because different areas of the body grow at different rates.

Hypothermia and Frostbite

Hypothermia is an abnormally low body temperature resulting from prolonged exposure to cold

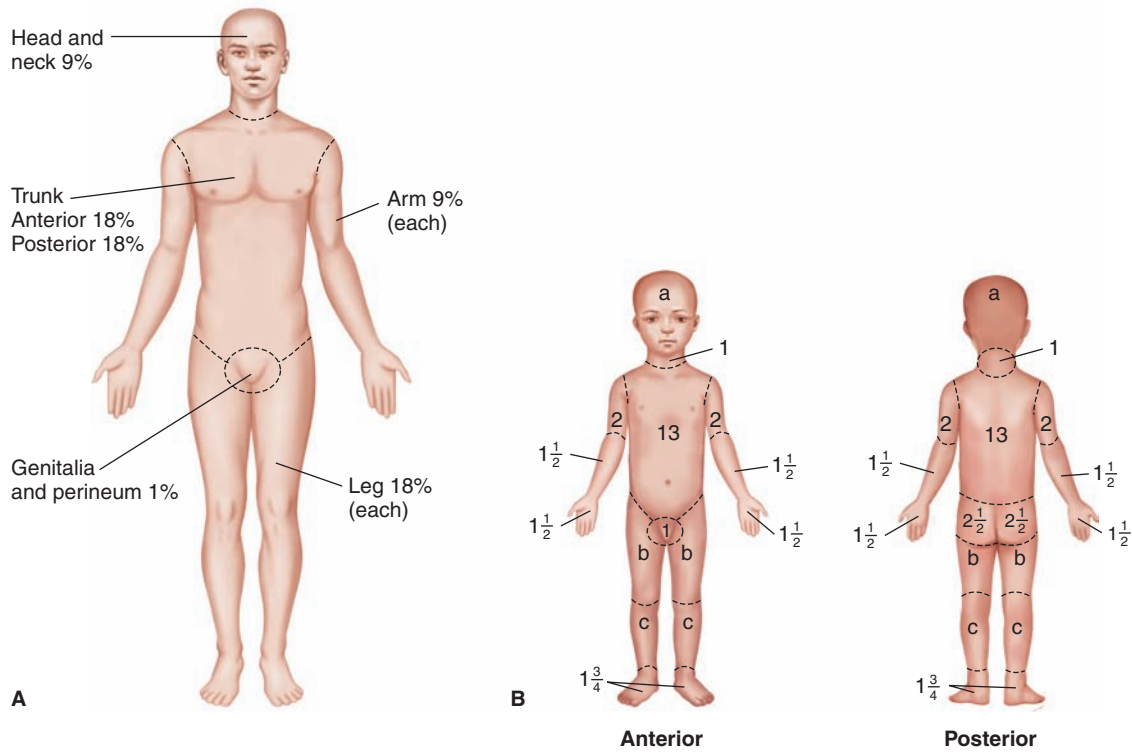


Figure 17-35 ► Third-degree burn.

air or water. Hypothermia occurs when more heat escapes from the body than the body can produce. Approximately 700 people in the United States die each year of hypothermia. Risk factors for hypothermia include age (young children and older adults have highest risk), impaired mental status, substance abuse, certain medical conditions that affect the body's ability to regulate temperature (hypothyroidism, poor nutrition, dehydration, stroke, severe arthritis, spinal cord injuries, Parkinson's disease), and some medications (certain antidepressants, antipsychotics, and sedatives). Signs and symptoms of hypothermia include shivering, cold and pale skin, lack of coordination, disorientation, and decreased heart rate, respiration, and blood pressure that can lead to loss of consciousness or death. Diagnosis is based on body temperature. Rewarming is the main treatment. Prevention includes dressing appropriately for the weather by wearing dry, loose-fitting, layered clothing that wicks moisture away from skin. Wet clothes should be replaced by dry and warm clothes. It is important to wear a hat because 30–50% of body heat is lost through the head. Alcohol should be avoided because it causes the blood vessels in the skin to dilate and lose heat to the environment.

Frostbite is damage to the skin caused by freezing from prolonged exposure to cold conditions. Risk factors for frostbite include medical conditions that affect sensation or the ability to respond to cold (dehydration, exhaustion, diabetes, peripheral neuropathy, circulatory problems), substance abuse, smoking, impaired mental status, previous frostbite or cold injury, and age (infant, older adult).

In superficial frostbite, signs and symptoms may include burning, numbness, tingling, itching, or cold sensations in the affected areas. The regions appear white and frozen, but if pressed on, they retain some resilience. In deep frostbite, there is an initial decrease in sensation that is eventually completely lost. Swelling and blood-filled blisters are noted over white or yellowish skin that looks waxy and turns a purplish blue as it rewarms. The area is hard, has no resilience when pressed on, and may even appear blackened and dead. Freezing causes formation of ice crystals within cells, rupturing and destroying the cells.



Relative percentage of body surface area (% BSA) affected by growth

Body Part	Age				
	0 yr	1 yr	5 yr	10 yr	15 yr
a = ½ of head	9½	8½	6½	5½	4½
b = ½ of 1 thigh	2¾	3¼	4	4¼	4½
c = ½ of 1 lower leg	2½	2½	2¾	3	3¼

Figure 17-36 ► Determining the extent of a burn: (A) rule of nines (adults); (B) Lund-Browder chart (children).

Frostbite can be diagnosed by visual inspection of the affected area and by taking a history. Various imaging techniques may be used to determine the severity and depth of tissue damage. Immediate treatment may include rewarming, pain medication, and IV fluids. After thawing and rewarming, treatment may include wound debridement, amputation, medications to reduce clotting, a tetanus vaccine booster if needed, anti-inflammatory medication, and hydrotherapy to remove dead tissue. Prevention includes dressing adequately for the weather by wearing loose-fitting, layered clothing, keeping clothes dry, refraining from smoking, and avoiding drugs and alcohol.

Age-Related Diseases

The composition and function of the skin changes with age. Skin loses some of its elasticity with age and the skin becomes wrinkled and saggy. Touch sensation of the skin decreases with aging, making burns and frostbite more likely. Stem cell production declines with aging, causing slower epidermal cell reproduction and thinner, more translucent skin that is more prone to injury and infection and retains less water. Migration of cells to the top of the epidermis slows. As a result, skin heals much more slowly in older adults compared to younger people. This longer healing time increases the risk of secondary infections.

Vascular and gland changes occur in the skin with age. Vascularity and circulation decrease in the subcutaneous tissue, causing drugs that are administered in this manner to be absorbed slowly. Vascular supply to the nails and hair decreases, resulting in slowed growth. Nails become dull, brittle, hard, and thick and become difficult to trim. A decrease in the blood supply to the dermis and a decrease in sweat production lead to impaired thermoregulation, placing older adults at an increased risk for hypothermia or overheating. Sebaceous gland activity decreases, as does sebum production. The skin becomes dry and flaky. Hair becomes brittle, thin, and may be lost.

Aging skin becomes less resistant to infection and other diseases. The number of macrophages and other cells of the immune system decrease and these cells are less efficient, increasing the risk of infection. Melanocyte number and activity declines with aging, causing the skin to become paler and the hair to turn gray or white. This also causes an increased susceptibility to sunburn and skin cancer. In addition, selected melanocytes increase their production in areas exposed to the sun, resulting in lentigines.

Seborrheic keratosis is a benign overgrowth of epithelial cells. Seborrheic keratoses are the most common benign tumor in older individuals. Most people develop at least one seborrheic keratosis at some point in their lives. Its prevalence is not known. Risk factors include being over age 50 and having a family history of seborrheic keratoses. A seborrheic keratosis has a characteristic “pasted-on” look and typically appears on the head, neck, or trunk of the body (Figure 17–37 ►). Seborrheic keratoses range in color from light tan to black, are round to oval-shaped, are flat or slightly elevated with a scaly surface, and range in size from very small to more than 1 inch across. Seborrheic keratosis may cause pruritus. The etiology of seborrheic keratoses is idiopathic. They tend to run in some families, so genetics may play a role. UV light may also play a role in their development. Diagnosis is by visual examination and a biopsy may be performed to rule out skin cancer. Treatment of seborrheic keratoses usually is not necessary; however, they can be removed by cryosurgery, curettage, laser, or electrocautery.

Actinic keratosis, also known as solar keratosis, is a precancerous skin condition. The Skin Cancer



Figure 17–37 ► Seborrheic keratosis. (Courtesy of the Centers for Disease Control and Prevention/Dr. Steve Kraus, 1981)

Foundation estimates that 58 million people in the United States have actinic keratosis. Risk factors include being over age 50, impaired immunity, living in a sunny climate, having a history of frequent or intense sun exposure or sunburn, and having a personal history of actinic keratosis or skin cancer. Actinic keratosis develops on areas of the body exposed to the sun such as the face, arms, and legs. Actinic keratoses are small (usually less than 1/4 inch) wartlike lesions that may be pink-red or flesh-colored (Figure 17–38 ►). Chronic sun exposure is the cause of almost all actinic keratoses. If actinic keratosis is not treated, 10–15% may develop into squamous cell carcinoma. Even

Healthy Aging

Promote Healthy Skin

A number of skin changes are caused by exposure to ultraviolet radiation. These include skin cancer, actinic keratosis, and liver spots (lentigenes). Ultraviolet radiation also damages the skin in other ways, altering its elasticity and composition. With time, sun-exposed skin becomes wrinkled, hardened, and dry. The easiest way to prevent sun-induced damage and disease is to reduce sunlight exposure by wearing sunscreen, sunglasses, hats, long-sleeved shirts, and long pants and by staying out of the sun in the middle of the day when the sun's rays are the most direct.



Figure 17–38 ► Actinic keratosis. (Copyright © JPD/Custom Medical Stock Photo)

though most actinic keratoses do not become cancers, they are a warning that the skin has suffered sun damage and should be checked regularly. Diagnosis of actinic keratosis is by visual examination and may include biopsy. Treatment of actinic keratosis may include removal via acid chemical peels, laser therapy, cryosurgery, photodynamic therapy, and topical medications. Topical medications may include chemotherapy agents to inhibit DNA synthesis, immune response modifiers to increase immune responses, nonsteroidal anti-inflammatories to decrease prostaglandins, and medications to induce cell death. The best way to prevent actinic keratosis is to limit exposure to UV radiation.

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Diseases at a Glance

Integumentary System

Disease or Disorder	Etiology	Signs and Symptoms
Epidermoid cysts	Abnormal cell proliferation	Smooth, flesh-colored to yellowish, round lumps just beneath the skin surface that are easy to move
Impetigo	Staphylococcal and streptococcal bacteria	Papule with erythema; vesicles that rupture after a few days and form a thick honey-colored crust, pruritis
Erysipelas, cellulitis	Staphylococcal and streptococcal bacteria	Swollen, bright red, hot, and tender area of the skin, small vesicles, fever, chills, swelling of lymph nodes
Folliculitis	Staphylococcal and streptococcal bacteria	Red, follicular-based papules and pustules, pruritus
Furuncles, carbuncles	<i>Staphylococcus aureus</i>	Furuncles—painful pustules that form in hair follicles Carbuncles—cluster of furuncles
Oral herpes	Herpes simplex virus-1	Clusters of painful, fluid-filled vesicles
Warts	Human papillomavirus	Benign neoplasm with rough, keratinized surface
Tinea	<i>Trichophyton rubrum</i> , <i>Trichophyton tonsurans</i>	Tinea corporis—a rash that begins as a small area of red, raised spots and papules. The rash slowly becomes ring-shaped, with a red-colored, raised border and a clearer center. The border may look scaly. Tinea pedis—scales and fissures on soles of feet and between toes, foul odor Tinea cruris—red, ring-like areas with vesicles Tinea capitis—single or multiple patches of hair loss that may have a black dot pattern, inflammation, scaling, pustules, and pruritis. Tinea unguium—thick, cracked nails Tinea barbae—deep, inflammatory pustule around hairs

Diagnosis	Treatment	Prevention
Visual examination	Removal by excision if required	Not preventable
Visual examination, culture	Antibiotics	Daily bathing, frequent handwashing, prompt attention to skin wounds
Visual examination, culture	Self-limiting, antibiotics	Prompt attention to skin wounds, keeping skin moisturized, and keeping fingernails short
Visual examination, culture	Antiseptic cleanser, antibiotics	Shaving with care, keeping skin moist and well hydrated, and avoiding unsanitary hot tubs and pools
Visual examination, culture	Moist heat, antiseptic skin cleansers, antibiotics, incision and drainage	Frequent handwashing with soap and water, prompt attention to skin wounds, keeping wounds covered, and keeping personal items personal
Visual examination, culture, antigen/antibody testing, herpes DNA testing	Self-limiting, antiviral drugs	Avoid infection with HSV-1, avoid outbreak triggers
Visual examination	Removal by medication, electrocautery, cryosurgery, laser surgery	Avoid touching warts, walking barefoot on warm moist surfaces, trauma to the skin
Visual examination, microscopic examination of skin scrapings	Keeping area clean and dry, antifungal medication	Keep skin clean, cool, and dry; wear sandals or shoes in gyms, locker rooms, and pools

Disease or Disorder	Etiology	Signs and Symptoms
Seborrheic dermatitis	Idiopathic	Adults: Dry or greasy scaling of the scalp with variable pruritis Infants: Thick, yellow-crusts scalp lesions
Candidiasis	Overgrowth of <i>Candida</i> , especially <i>Candida albicans</i>	Vaginal: white cottage-cheese discharge, burning, pruritus, erythema Oral: Creamy white, painful patches on tongue or side of mouth Cutaneous: patches of red, moist, weepy skin
Pediculosis	<i>Pediculus humanus capitis</i> , <i>Pediculus humanus corporis</i> , <i>Phthirus pubis</i>	Pruritus, multiple erythematous papules
Scabies	<i>Sarcoptes scabiei</i>	Pruritus, vesicles, pustules, grayish lines (tunnels)
Urticaria (hives)	Hypersensitivity	Wheals with rounded elevations and pale centers, pruritus
Allergic contact dermatitis	Type I hypersensitivity	Rash with erythema, pruritus, burning
Atopic dermatitis	Idiopathic	Red, dry, crusted patches on the skin
Rosacea	Idiopathic	Flushing, persistent erythema, papules pustules, telangiectasias Ocular-burning, grittiness, watery, itchy, blood shot eyes
Psoriasis	Idiopathic	Red, inflamed lesions covered with silvery white scales
Nevus (mole)	Idiopathic	Small, dark skin growth
Hemangioma	Idiopathic	Red or purple birthmarks
Basal cell carcinoma	UV radiation damaging DNA	Pearly nodule with rolled edges may bleed, form a crust

Diagnosis	Treatment	Prevention
Visual examination, biopsy	Medicated shampoo, antifungal medication, corticosteroids	Not preventable
Visual examination, microscopic examination, culture	Antifungal medication	Keeping skin clean and dry, appropriate antibiotic use, healthy diet
Finding lice, nits	Pediculicide medication	Proper hygiene, avoiding contact with infected individuals
Visual examination, microscopic examination of skin scrapings	Scabicide medication	Proper hygiene, avoiding contact with infected individuals
Visual examination, complete medical history	Corticosteroids, antihistamines, calamine lotion	Avoid allergen, reduce emotional and physical stress
Visual examination	Corticosteroids, antihistamines	Avoid allergen
Visual examination	Corticosteroids, immunomodulators	Not preventable
Visual examination	Antibiotics, vitamin A derivatives, laser surgery	Avoid triggers
Visual examination	Salicylic acid, coal tar, corticosteroids, antiproliferatives, phototherapy, immunosuppressants, immunomodulators, monoclonal antibodies	Not preventable
Visual examination, biopsy	Excision, cryosurgery	Not preventable
Visual examination, biopsy	Laser therapy, corticosteroids, surgical excision	Not preventable
Visual examination, biopsy	Surgery, chemotherapy, radiation therapy, photodynamic therapy, immunomodulators	Limit UV radiation exposure, examine skin on a regular basis

Disease or Disorder	Etiology	Signs and Symptoms
Squamous cell carcinoma	UV radiation damaging DNA	Crusted nodule, ulcerates and bleeds
Melanoma	UV radiation damaging DNA	Change in size, color, shape, feel of an existing mole
Acne	Overproduction of sebum, blockage of hair follicles, growth of <i>Propionibacterium acnes</i>	Comedones, papules, pustules, nodules
Albinism	Hereditary	Absence of melanin
Vitiligo	Idiopathic	White, well-demarcated areas of skin without melanin
Ephelides	Hereditary	Red or brown macule
Lentigines	Exposure to UV radiation	Small, pigmented spots with clearly defined edges; "liver spots"
Melasma	Idiopathic	Patches of darker skin on the face
Pressure ulcer	Sustained pressure, friction, shear	Varies depending on stage; discolored skin, vesicle, ulcer, slough, eschar, undermining, tunneling
Corns and calluses	Repeated pressure and friction, ill-fitting shoes or socks, not wearing shoes or socks, manual labor, bony prominences, biomechanical or gait abnormalities	Areas of skin that grow thick

Diagnosis	Treatment	Prevention
Visual examination, biopsy	Surgery, chemotherapy, radiation therapy, photodynamic therapy, immunomodulators	Limit UV radiation exposure, examine skin on a regular basis
Visual examination, biopsy	Surgery, chemotherapy, radiation therapy, immunotherapy, targeted therapy	Limit UV radiation exposure, examine skin on a regular basis
Visual examination	Antibiotics, vitamin A derivatives, benzoyl peroxide, hormone therapy	Not preventable
Visual examination, genetic testing	Improving vision, protecting eyes from bright light, protecting the skin and eyes from the sun	Not preventable
Visual examination	Repigmentation agents, UV light treatment, depigmentation agents, surgical treatment	Not preventable
Visual examination	Chemical peel, cryotherapy, laser therapy	Not preventable
Visual examination	Depigmentation agents, vitamin A derivatives, chemical peel, cryotherapy, laser therapy	Protecting skin from the sun
Visual examination	Corticosteroids, depigmentation agents, vitamin A derivatives, chemical peel, laser therapy	Protecting skin
Visual examination, culture, blood tests	Eliminate pressure, wound debridement, antibiotics, pain management, healthy diet, muscle spasm relief, meticulous wound care	Turn and reposition patients every 2 hours, use specialized support surfaces, protecting and monitoring condition of the skin, proper nutrition, not using tobacco
Visual examination, x-ray	Shaving or cutting off the hardened area on the skin, removal by medication or surgery, surgically removing areas of protruding bone	Wear gloves to protect hands, make sure shoes and socks fit properly and do not rub, surgically correct bony abnormalities, and keep hands and feet moisturized

Disease or Disorder	Etiology	Signs and Symptoms
Burns	Heat, radiation, sunlight, chemicals, electricity	First-degree: red, swollen, painful Second-degree: extremely red, blistered, painful Third-degree: white or brown skin with a dry, leathery appearance, no pain in the burned area Fourth-degree: black and charred with eschar, no pain in the burned area
Hypothermia, frostbite	Prolonged exposure to cold air or water	Hypothermia: shivering, cold and pale skin, lack of coordination, disorientation, decrease in HR, RR, BP, loss of consciousness Frostbite: burning, numbness, tingling, itching, cold sensation, loss of sensation, blistering, tissue death

Diagnosis	Treatment	Prevention
Visual examination	<p>First-degree: none</p> <p>Second-degree: antibiotic cream, pain relievers</p> <p>Third-degree: IV fluids, antibiotics, pain relievers, surgical debridement, grafting</p> <p>Fourth-degree: surgery, grafting, amputation</p>	Avoid excessive exposure to heat, radiation, sunlight, chemicals, and electricity
Hypothermia: body temperature	Hypothermia: rewarming	Hypothermia: dress appropriately for the weather in loose layers, hat, keep clothing dry, avoid alcohol
Frostbite: visual examination, visual imaging techniques	Frostbite: rewarming, pain medication, IV fluids, debridement, amputation, tissue plasminogen activator, tetanus booster, anti-inflammatory medication, hydrotherapy	Frostbite: dress appropriately for weather in loose layers, keep clothing dry, do not smoke, avoid alcohol and drugs

Interactive Exercises

Cases for Critical Thinking

1. A 4-year-old girl has red lesions with a honey-colored crust under her nose and on her cheek. According to her mother, the lesions appeared shortly after she developed a cold. On examination, the doctor notes that the girl's lymph nodes are still swollen. What is your diagnosis? What is the cause? What is the treatment?
2. A 25-year-old man complains of intense jock itch. On examination, the doctor observes raised lesions on his penis and red circular patches on his groin. The patient lives in a transient hotel, and his hygiene is poor. What are the possible causes for this rash? What diagnostic tests should the doctor order?
3. A 39-year-old woman who plays tennis for hours a day during the spring and summer notices a lesion on her ear that bleeds. What are the possible diagnoses? What diagnostic tests should be ordered?
4. Fifteen-year-old Jeremy has a bad case of acne. According to his mom, Jeremy's acne is from too much late-night TV, frozen pizza, and cheddar popcorn. What factors contribute to acne? What treatments are available? Can acne be prevented?
5. Dudley has small, painful vesicles near his mouth. What is your diagnosis? How did Dudley become infected? What treatments are available?
6. Leylah joined a gym to get in better shape. Since she has been working out at the gym, she has noticed hard, thick patches of skin with dark specks on the sole of one of her feet. They are very painful. What is your diagnosis? What is the cause? What is the treatment?

Multiple Choice

1. A small, elevated lesion filled with pus is a _____.
a. macule
b. papule
c. nodule
d. vesicle
2. A discolored spot of the skin is a _____.
a. nodule
b. macule
c. wheal
d. cyst
3. A sac filled with a fluid or semi-fluid material is a _____.
a. nodule
b. cyst
c. wheal
d. macule
4. The outermost layer of the skin is the _____.
a. epidermis
b. subcutaneous tissue
c. dermis
d. keratin
5. In pallor, the skin appears _____.
a. blue
b. red
c. white
d. brown
6. The _____ lies under the dermis and connects the skin to underlying structures.
a. epidermis
b. dermis
c. subcutaneous tissue
d. stratum corneum

7. Solid elevated areas of the skin are called _____.
 - a. pustules
 - b. macule
 - c. papule
 - d. nodule
8. Folliculitis is an inflammation of _____.
 - a. sebaceous glands
 - b. sweat glands
 - c. hair follicles
 - d. furuncles
9. Pediculosis is a _____ infection.
 - a. parasitic
 - b. bacterial
 - c. viral
 - d. fungal
10. _____ is a lubricant that keeps the skin soft and moist and prevents hair from becoming brittle
 - a. Macula
 - b. Keratin
 - c. Sebum
 - d. Wheals

True or False

- _____ 1. Tinea unguium is a bacterial infection.
- _____ 2. Basal cell carcinoma metastasizes rapidly.
- _____ 3. Melasma is loss of melanin resulting in white patches of skin.
- _____ 4. Seborrheic dermatitis is a malignant skin tumor.
- _____ 5. The buttock region is the most common area for pressure ulcers to develop.
- _____ 6. Actinic keratosis is a type of skin cancer.
- _____ 7. Ringworm is a viral infection.
- _____ 8. Erythema is whitening of the skin.
- _____ 9. The etiology of seborrheic dermatitis is idiopathic.
- _____ 10. Rosacea is a fungal infection.

Fill-Ins

1. _____ is the pigment of the skin that protects the skin cells from UV radiation.
2. _____ is an infestation of lice.
3. The _____ lies below the epidermis and is composed of fibrous connective tissue containing collagen and elastin fibers.
4. A _____ is a small localized elevation of skin that is often accompanied by pruritus.
5. _____ is a contagious parasitic mite skin disease usually associated with poor living conditions.
6. _____ is a chronic skin disease characterized by scaling and inflammation.
7. _____ are caused when blood vessels are damaged or broken as a result of a blow to the skin.
8. _____ is a benign tumor made of small blood vessels that form a red or purple birthmark.
9. _____ is loss of melanin resulting in white patches of skin.
10. _____ causes scales and fissures on the soles of the feet and between toes.

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Appendix A

Glossary

Abdominal aortic aneurysm. Weak, dilated wall of the aorta in the abdominal region.

Acetylcholine. Neurotransmitter of the parasympathetic nervous system.

Achlorhydria. Condition in which hydrochloric acid is absent in the stomach.

Achondroplasia. Autosomal dominant disorder of defective cartilage formation in the fetus.

Achondroplastic dwarfism. Condition caused by defective cartilage formation that results in improper bone development.

Acidosis. Condition in which the production of acids lowers the body's pH.

Acquired immunodeficiency syndrome (AIDS). Deadly disease caused by HIV that destroys an individual's immune system, making the victim remarkably susceptible to infection.

Acrodermatitis enteropathica. Rare autosomal recessive disorder that results in defective malabsorption of zinc.

Acromegaly. Result of excess GH secretion in adulthood.

Actinic keratosis. Precancerous skin condition.

Acute. Describing a disease that has a sudden onset and a short duration.

Adaptive behavior. Use of everyday social and practical skills.

Addison's disease. Result of undersecretion of hormones by the adrenal cortex.

Adenocarcinoma. Cancerous glandular tumor.

Adhesions. Fusions between the surfaces of normally separate organs or tissues.

Adenohypophysis. Anterior portion of the pituitary gland.

Adenoma. Benign tumor of glandular tissue that often develops in the breast, thyroid gland, or mucous glands of the intestinal tract.

Adipose. Fatty; descriptive of tissue in which fat cells accumulate.

Adrenalin. Hormone of the sympathetic nervous system; the most vital therapy in treatment of anaphylaxis and can be self-injected in an emergency.

Adrenal virilism. Expression of secondary male sexual characteristics in females caused by a testosterone-secreting adrenal gland neoplasm.

Adrenocorticotrophic hormone (ACTH). Hormone that stimulates the release of corticosteroids.

Adrenogenital syndrome. Form of hyperadrenalism caused when the male hormone is excessively secreted.

Agglutinate. To clump or aggregate, as occurs in some antibody-antigen reactions.

Albinism. Autosomal recessive disorder in which no melanin is formed, causing a person to have white hair, pale skin, and pink eyes.

Albuminuria. Presence of the plasma protein albumin in urine.

Aldosterone. Principle hormone from the adrenal cortex that causes sodium retention and potassium secretion by the kidneys.

Alleles. Alternative forms of a gene.

Allergic contact dermatitis. Localized inflammation of the skin caused by contact with an allergen.

Allergy. Extreme immune response to an antigen.

Alpha cells. Glucagon-secreting cells of the endocrine pancreas.

Alpha-feto-protein. Fetal protein found in maternal blood, and sometimes detected in adults with various cancers.

Alveoli. Small air sacs in the lungs where gas exchange occurs.

Alzheimer's disease. Most common cause of dementia; an irreversible, progressive brain disease that slowly destroys memory and thinking.

Amenorrhea. Absence of menstruation.

Amniocentesis. Diagnostic test for hereditary diseases performed on fetal cells withdrawn from amniotic fluid.

Amoeboid. Type of protozoa that moves with pseudopodia.

Amylase. Digestive enzyme that breaks down carbohydrates.

Amyotrophic lateral sclerosis (ALS). Chronic, terminal, degenerative disease of the motor nervous system; also known as Lou Gehrig's disease.

Analgesics. Medications that reduce pain.

Anaphylactic shock. Severe inflammation brought on by an antigen-antibody reaction such as occurs in an incompatible blood transfusion.

Anaphylaxis. Condition of anaphylactic shock, a life-threatening state in which blood pressure drops and airways become constricted.

Androgen. Sex hormone in males.

Anemia. Condition caused by a reduction of oxygen-carrying hemoglobin.

Aneurysm. Localized dilation caused by a weakening in the wall of a blood vessel.

Angina pectoris. Temporary chest pain or sensation of chest pressure caused by transient oxygen insufficiency.

Angiocardiology. X-ray of the heart and great vessels in which a contrast indicator (dye) is injected into the cardiovascular system.

Angioma. Benign tumor composed of blood vessels, such as a red birthmark or “port-wine” stain.

Angioplasty. Procedure by which a balloon-tip catheter is inserted into the coronary arteries and expanded to break and crush plaque buildup.

Ankylosis. Scar tissue formation at bone ends that can turn to bone, causing the ends to fuse.

Anorexia. Loss of appetite.

Anorexia nervosa. People with this disorder see themselves as overweight, even when they are clearly underweight. Eating, food, and weight control become obsessions.

Antibiotic resistance. Drug resistance among bacteria; bacteria adapt to antibiotics and the adaptation becomes common in the bacterial population, rendering the antibiotics ineffective.

Antibiotics. Drugs used to treat bacterial infections.

Antibodies. Proteins secreted by plasma cells that aid in defense against infectious agents.

Anticoagulant. Medication used to prevent intravascular clotting.

Antidiuretic hormone (ADH). Stimulates water absorption by the kidneys.

Antigen. Any foreign substance that when introduced into the body is recognized as nonself and activates the immune system.

Anuria. Total stoppage of urine production.

Anxiety disorders. Mental disorders characterized by excessive fear and anxiety.

Aorta. Largest artery in the body; carries blood away from the heart to the arteries.

Aortic stenosis. Narrowing of the valve leading into the aorta.

Aphasia. Loss of speech.

Aplasia. Developmental failure leading to the absence of a structure or tissue.

Apoptosis. Programmed cell death.

Arrhythmia. Deviation from the normal rhythm of the heartbeat.

Arterial blood gas (ABGS). Blood test that is performed to determine the concentration of oxygen,

carbon dioxide, and bicarbonate, as well as the pH of the blood.

Arterioles. Smallest arteries, capable of constriction and dilatation.

Arteriosclerosis. Progressive hardening of blood vessels, especially arteries.

Arthritis. Inflammation of a joint.

Ascaris. Large roundworm intestinal parasite.

Ascites. Fluid that develops as a result of liver failure and accumulates in the peritoneal cavity.

Aspermia. When there is no formation or emission of sperm resulting from the absence of the gonadotropic hormones in a male before puberty.

Asthma. Condition in which the bronchial tubes in the lungs react to different stimuli by becoming inflamed.

Astigmatism. Cornea of the eye that has an irregular curvature or the lens that has irregularities.

Astrocytoma. Basically benign, slow-growing tumor of the brain.

Atelectasis. Collapse of lung tissue affecting part or all of one lung.

Atherosclerosis. Accumulation of fatty material under the inner lining of the arterial wall.

Atopic dermatitis. Most common type of eczema; chronic skin disease that is frequently associated with other atopic (allergic) conditions including asthma and hay fever.

Atresia. Absence or closure of a normal body opening or tubular structure.

Atrophic. Degenerating, wasting condition.

Atrophy. Decrease in size or function of an organ.

Attention-deficit/hyperactivity disorder. Disorder characterized by a persistent pattern of inattention and/or hyperactivity.

Aura. Warning signal such as the symptoms that precede an epileptic seizure.

Auscultation. Listening with a stethoscope for sounds within the body, such as heart valve sounds or the lungs, during an exam.

Autism spectrum disorders. Range of complex developmental disorders that can cause problems with thinking, feeling, language, and the ability to relate to others.

Autoantibodies. Antibodies produced by the immune system against the individual's own tissue, cells, or cell components.

Autoimmunity. Development of antibodies, called autoantibodies, to one's own tissues or self antigens.

Autosomal dominant trait. A trait that is inherited by a person when only one of a pair of chromosomes, from either the person's father or the mother, has the trait.

Autosomal recessive trait. A trait that is inherited by a person only when both of a pair of chromosomes, from both the person's father and from the mother, has the trait.

Autosomes. Name for 44 of the 46 chromosomes, the 22 pairs of chromosomes in which one is inherited from the mother and the other inherited from the father; autosomes are all the chromosomes other than the sex chromosomes, which are known as allosomes.

B cell. Lymphocyte that provides humoral immunity.

Bacilli. Rod-shaped bacterial cells.

Bacteria. Single-celled organisms with simple structure and lacking a nucleus.

Basal cell carcinoma. Slow-growing and generally nonmetastasizing tumor.

Basal ganglia (basal nuclei). Nerve cell bodies deep within the white matter of the brain that help control position and unconscious movements.

Basophils. White blood cells that promote inflammation and participate in allergic responses.

Benign. Noncancerous neoplasm or tumor.

Benign prostatic hyperplasia (BPH). Enlargement of the prostate gland.

Beriberi. Thiamine deficiency; includes dry or wet syndromes, cerebral beriberi, and Wernicke-Korsakoff syndrome.

Beta cells. Insulin-secreting cells of the endocrine pancreas.

Beta human chorionic gonadotropin. Hormone secreted during pregnancy.

Bile. Substance secreted by the liver and necessary for fat digestion; consists of water, bile salts, cholesterol, and bilirubin.

Biliary. Pertaining to gallbladder or bile ducts.

Biliary calculi. Gallstones; consist mainly of cholesterol, bilirubin, and calcium.

Biliary cirrhosis. Destruction of bile ducts of the liver resulting from cholecystitis.

Bilirubin. Colored pigment produced when hemoglobin breaks down.

Binary fission. Process in which bacteria reproduce by splitting in half.

Binge eating disorder. Regular episodes of extreme overeating without attempts to compensate for the behavior.

Biopsy. Procedure in which a small sample of a tissue is surgically removed and examined microscopically for abnormalities.

Bipolar disorder. Unusual shifts in mood, energy, activity levels, and the ability to carry out day-to-day tasks; characterized by alternating extremes of depression and euphoria.

Bowman's capsule. Sac containing the glomerular capillaries; also called glomerular capsule.

Bradycardia. Heart rate of 60 beats per minute or less; a slow heart rate.

Bradykinesia. Slowness of movement.

Bradypnea. Slow respiration rate.

Bronchi. Tubular passageways from the trachea to the lungs.

Bronchiectasis. Weakened and dilated bronchial tubing.

Bronchioles. Small soft tissue tubules with smooth muscle wrappings that connect small bronchi to alveolar structures in the lungs.

Bronchitis. Inflammation of the bronchi; may be acute or chronic.

Bulbourethral glands. Secrete a clear fluid into the urethra during sexual arousal that serves as a lubricant for sexual intercourse and neutralizes the acidity of residual urine in the urethra.

Bulimia nervosa. Cycles of extreme overeating, followed by behavior that compensates for the overeating such as vomiting, use of laxatives, fasting, and excessive exercise.

Bundle of His. Specialized tissue in heart muscle capable of sending the impulse for contraction to the ventricles.

Bursa. Sac of fluid situated near the joint to reduce friction on movement.

Bursitis. Inflammation of a bursa.

Cachexia. Condition of weakness and emaciation caused by the rapid growth of a malignant tumor; also accompanies many chronic diseases such as cancer, HIV/AIDS, and tuberculosis.

Calcium. Mineral essential for bone and tooth structure and for cell physiology.

Capillaries. Thin-walled blood vessels connecting arterioles and venules; site of oxygen and carbon dioxide gas exchange with body tissues.

Capsid. Protein shell around a virus particle.

Carbuncles. Clusters of furuncles.

Carcinogens. Cancer-causing agents or substances.

Carcinoma. Type of cancer affecting epithelial tissues, skin, and mucous membranes lining body cavities, or glandular tissue such as the breast, liver, or pancreas.

Cardiac. Pertaining to the heart.

Cardiac catheterization. Procedure in which a catheter is passed into the heart through appropriate blood vessels to sample the blood in each chamber for oxygen content and pressure.

Cardiac sphincter. Muscular gateway between the esophagus and stomach.

Cardiopulmonary resuscitation (CPR). Heart and lung assistance by trained personnel to rhythmically compress the chest and breathe into a victim's airway until medical services can be provided.

Carotene. Plant pigment from which vitamin A is derived.

Carotid artery. Artery carrying blood along the neck to the brain.

Caseous. Soft, cheese-like; characteristic of lung tissue in tuberculosis.

Casts. Tiny tubular particles in the urine, visible under a microscope, consisting of coagulated protein and blood.

Cataracts. Clouding of the eye lens to the point of opacity.

Cell walls. Rigid layer of organic material surrounding delicate cell membranes.

Cell-mediated immunity. Immune response in which cells such as phagocytes and T-cells provide defense against abnormal cells, transplanted tissues and organs, and intracellular pathogens; immunity provided by special cells in contrast to humoral immunity that is provided by antibodies.

Cellulitis. Severe inflammation of the skin that extends into the subcutaneous tissue.

Cerebral. Pertaining to the brain, specifically the cerebral hemispheres.

Cerebral aneurysm. A weakened, dilated artery within the brain.

Cerebrospinal. Pertaining to the brain and spinal cord; cerebrospinal fluid bathes these organs.

Cervical. Of or relating to the neck.

Cervix. Narrow portion of the uterus that protrudes into the vagina.

Chancere. Ulceration on the genitals in the primary stage of syphilis.

Chemotherapy. Systemic administration of medications to kill malignant cells.

Chitin. Polysaccharide in the walls of some fungal cells.

Chlamydia. Sexually transmitted infection caused by *Chlamydia trachomatis*.

Cholecystectomy. Surgical removal of the gallbladder.

Cholecystitis. Inflammation of the gallbladder.

Cholelithiasis. Formation or presence of gallstones.

Cholesterol. Fatty substance found in animal cell membranes.

Choriocarcinoma. Malignant tumor of the placenta.

Chorionic villus sampling. Genetic test involving the removal of cells from the villi through the cervix.

Chromosome. Molecule of DNA found in the human cell. Each human cell contains 46 chromosomes divided into 23 pairs.

Chronic. Description of a disease that is long-lasting or frequently recurring.

Chronic kidney disease. Long-term and irreversible decline in kidney function, often ending in kidney failure.

Chronic obstructive pulmonary disease (COPD). Disease characterized by airflow limitation that is preventable and treatable but not fully reversible.

Chronic ulcerative colitis. Serious inflammation of the colon, the origin of which is unknown.

Chymotrypsin. Digestive enzyme that digests protein.

Cilia. Hairlike projections such as those found in the mucous membrane that lines the respiratory tract.

Ciliates. Protozoa that move using hairlike cilia.

Cirrhosis. Chronic destruction of liver cells and tissues with a nodular, bumpy regeneration.

Clitoris. Tuft of erectile tissue whose function is sexual arousal and pleasure.

Coarctation. Narrowing, or stricture, of the aorta that provides blood to the entire body.

Cocci. Spherical bacterial cells.

Collagen. Fibrous protein found in connective tissues.

Colostomy. Artificial opening in the abdominal wall to which a segment of the large intestine is attached, providing a channel for feces to leave the body.

Colposcopy. Diagnostic procedure using a magnifying device to visualize the vulva, vagina, and cervix.

Common warts. Rough, dome-shaped, warts that are gray-brown in color.

Communicable. In reference to infectious disease, the ability to be transmitted from human to human.

Compact bone. Dense bone tissue that forms the hard outer layer of most bones.

Complications. Conditions that develop in a patient already suffering from a disease.

Compression sclerotherapy. Treatment for varicose veins in which a strong saline solution is injected into specific sites within the vessel tract.

Computerized tomography (CT scan). Diagnostic imaging technique used to make diagnosis and determine the location of lesions or growths inside the body.

Concussion. Transient disorder of the nervous system resulting from a violent blow to the head or from a fall.

Cone biopsy. Procedure in which a cone-shaped wedge of abnormal tissue is removed from the cervix and examined under a microscope.

Congenital disorders. Disorders that appear at birth or shortly after but are not caused by genetic or chromosomal abnormalities.

Conjunctiva. Membrane that lines the eyelids and covers the eyeball.

Conn's syndrome. Form of hyperadrenalism in which aldosterone is excreted in excess.

Consumptive coagulopathy. A condition of increased intravascular blood clotting, also known as disseminated intravascular coagulation.

Contagious. Infectious disease transmitted from human to human.

Continuous positive airway pressure (C-PAP). Delivers air into the airway through a specially designed nasal mask or pillow; the flow of air creates enough pressure when inhaled to keep the airway open.

Cor pulmonale. Serious heart condition in which the right side of the heart fails as a result of longstanding chronic lung disease.

Coronary arteriography. Selective injection of contrast material into coronary arteries for a film recording of blood vessel action.

Corpus luteum. What is left of the ovarian follicle after a woman ovulates. The corpus luteum secretes progesterone.

Cortisone. Hormone of the adrenal gland that has anti-inflammatory properties.

Cortisol. A glucocorticoid hormone secreted in the adrenal cortex that helps to regulate carbohydrate, lipid, and protein metabolism. A form of cortisol, hydrocortisone is used as a medication to treat people who do not produce adequate cortisol.

Creatinine. Nitrogen-containing waste products of protein metabolism.

Cri du chat syndrome. Hereditary disease resulting from the deletion of part of the short arm of chromosome 5; the name comes from the characteristic cat-like cry of an infant with this disease.

C-reactive protein test. Measures general levels of inflammation in the body.

Cretenism. Congenital thyroid deficiency in which thyroxine is not synthesized.

Crohn's disease. Inflammatory disease of the intestine in which the intestinal walls become thick and rigid.

Croup. Loud cough that resembles the barking of a seal, difficulty breathing, and a grunting noise or wheezing during breathing.

Cryosurgery. Technique that uses extreme cold to freeze and destroy skin conditions and tumors.

Cryptorchidism. Failure of the testes to descend from the abdominal cavity, where they develop during fetal life, to the scrotum.

CT scan. Computed tomography scan; three-dimensional computer-aided x-ray.

Cushing's syndrome. Condition resulting from excessive levels of glucocorticoid hormones.

Cyanosis. A blue tint to the skin.

Cyst. Sac or capsule containing fluid; usually harmless.

Cystic fibrosis. Disease that affects all the exocrine glands of the body, the glands of external secretion usually affecting children.

Cystitis. Inflammation of the urinary bladder, commonly called a bladder infection.

Cystocele. Urinary bladder is displaced into the vagina.

Cystoscope. Endoscope (lighted scope) through which the interior of the urinary bladder is made visible for observation.

Cytoscopy. Diagnostic procedure using a cystoscope to view the urethra and bladder.

Cytotoxic T cells. Cells that recognize and eliminate infected and abnormal cells.

Defibrillator. Machine that delivers electrical shocks used to reestablish normal heart rhythm.

Delirium tremens. Medical emergency caused by heavy drinking over a long period of time; may occur after withdrawal from heavy alcohol intake.

Delta cells. Somatostatin-secreting cells of the pancreas.

Delusions. False beliefs about what is taking place or who one is.

Dementia. Organic loss of intellectual functions.

Deoxyribonucleic acid (DNA). Blueprint for protein synthesis within the cell.

Dermatitis. Noncontagious skin disorder.

Dermatophytes. Fungi that infect the skin and tend to live on the top of the epidermis.

Diabetes insipidus. Disease that results from a deficiency of ADH.

Diabetes mellitus. Endocrine disease in which the beta cells fail to secrete insulin or target cells fail to respond to insulin.

Diabetic nephropathy. Kidney disease resulting from diabetes mellitus.

Diagnosis. Process of identifying a disease or disorder from its signs and symptoms.

Diaphragm. Primary muscle for inspiration that divides the thoracic cavity from the abdominopelvic cavity.

Diastole. Period of the heartbeat when the heart relaxes and fills with blood.

Diastolic. Pertaining to the diastole, the relaxing stage of heart cycle.

Diethylstilbestrol (DES). Synthetic hormone used in the 1950s and early 1960s to prevent spontaneous abortion.

Dilated cardiomyopathy. Progressive congestive heart failure characterized by enlarged ventricles.

Diploid. The genetic condition of body cells that possess two copies of each chromosome. All cells are diploid except gametes (eggs and sperm).

Disease. Deviation from normal structure or function that interrupts or modifies the performance of vital functions.

Disinfection. Reducing the risk of infection or contamination.

Dislocation. Traumatic injury to joint in which bones move from normal functional position.

Disorder. Functional abnormality of the body or mind.

Disseminated intravascular coagulation (DIC). Systemic clotting of blood.

Diuretic. Substance that causes the kidneys to excrete water; can be administered as a drug to lower blood pressure.

Diverticula. Little pouches or sacs formed when the mucosal lining pushes through the underlying muscle layer.

Diverticulitis. Inflammation of the diverticula, usually occurring in the colon or small intestine.

Diverticulosis. Dilated pockets of the colon or small intestine.

DNA repair genes. Also known as caretaker genes; responsible for the repair of errors in normal DNA replication.

Dominant. Gene that is expressed when inherited.

Dopamine. Neuronal transmitter substance.

Doppler echocardiography. Instrument that uses echoes of moving blood columns to produce images of the vessel wall outline; the velocity of the blood is measured and the degree of carotid stenosis is determined.

Down syndrome. Chromosomal disorder that causes cognitive impairment; also called Trisomy 21.

Duodenal ulcers. Ulcers of the small intestine caused by an excessive secretion of hydrochloric acid and *Helicobacter pylori* infection.

Duodenum. First section of the small intestine; receives digested material from the stomach.

Dysentery. Acute inflammation of the colon, a colitis.

Dysmenorrhea. Painful or difficult menses.

Dyspareunia. Painful sexual intercourse.

Dysphagia. Difficult or painful swallowing.

Dysphonia. Hoarseness.

Dyspnea. Shortness of breath.

Dystrophin. Skeletal protein that is missing in Duchenne's muscular dystrophy.

Dystrophy. Muscle degeneration that disables an individual.

Dysuria. Painful urination.

Ecchymoses. Hemorrhagic spots that develop on the skin and in mucous membranes, causing discoloration.

Echocardiography. Noninvasive procedure (ultrasound cardiography) that uses high-frequency sound waves to examine the size, shape, and motion of heart structures.

Eclampsia. Convulsions and coma that follow untreated pregnancy-induced hypertension.

Ectopic pregnancy. Pregnancy in which the fertilized ovum implants in a tissue other than the uterus, most commonly in the fallopian tubes.

Edema. Swelling caused by leakage of plasma into tissues.

Electrocardiogram (ECG). Electrical recording of the heart action that aids in the diagnosis of coronary artery disease, myocardial infarction, valvular heart disease, and some congenital heart diseases.

Electroencephalography (EEG). Recording of brain waves.

Electrolyte balance. Proper balance of salts, such as potassium and calcium.

Electromyogram (EMG). Testing procedure used to diagnose muscle and nerve disorders.

Emboli. Circulating blood clots.

Embolism. The condition of a circulating blood clot.

Emerging infectious disease. New infection or an uncommon infection that is increasing in incidence.

Emphysema. Long-term, progressive obstructive lung disease in which the alveoli that promote oxygen exchange between the air and the bloodstream are destroyed.

Encephalitis. Inflammation of the brain and meninges, caused by a viral infection.

Encephalomyelitis. Acute inflammation of the brain and spinal cord.

Endarterectomy. Surgical procedure used to treat a blockage in an artery by removing the thickened area of the inner vascular lining.

Endemic. Disease that is always present at low levels in a population.

Endocarditis. Inflammation within the heart.

Endocardium. Smooth delicate membrane that lines the chambers of the heart.

Endometriosis. Condition in which endometrial tissue from the uterus becomes embedded elsewhere.

Endorphins. Naturally occurring molecules made up of amino acids, the building blocks of proteins that attach to special receptors in the brain and spinal cord to stop pain messages. These are the same receptors that respond to morphine and other opioid analgesics.

Endoscope. Instrument consisting of a hollow tube with a lens and light system used to view the inner surface of the digestive tract.

Endoscopic sclerotherapy. Procedure used to guide a retractable needle device through an area such as the esophagus to seal off vessels such as esophageal varices with a hardening agent.

Endoscopy. Imaging technique using flexible tubing mounted with a camera and surgical tools.

Endospores. Structures produced by bacteria and formed to cope with harsh environmental conditions.

Endotoxin. Potent toxin from certain bacteria that causes life-threatening shock.

Enkephalins. Naturally occurring molecules in the brain that attach to special receptors in the brain and spinal cord to stop pain messages. These are the same receptors that respond to morphine and other opioid analgesics.

Enuresis. Disorder of elimination that involves the voluntary or involuntary release of urine into bed-ding, clothing, or other inappropriate places; commonly called bed-wetting.

Enzyme immunoassay. Uses an enzyme to label either the antibody or antigen.

Eosinophilia-myalgia syndrome. Multisystem disease with pain, fatigue, and elevations of circulating blood eosinophils.

Eosinophils. White blood cells that kill parasites and are involved in allergic responses.

Ephelides. Freckles.

Ephylis. Freckles.

Epidemic. Occurrence of a disease in unusually large numbers over a specific area.

Epidemiology. Study of the occurrence, transmission, and control of diseases.

Epididymitis. Inflammation of the epididymis.

Epidural. Hemorrhage between the dura mater and the skull.

Epilepsy. Uncontrolled cerebral discharges that recur at random intervals.

Epinephrine. A hormone and neurotransmitter composed of chains of amino acids.

Erectile dysfunction (ED). Inability to achieve and maintain an erection sufficient for sexual intercourse; also known as impotence.

Erysipelas. Superficial bacterial infection of the skin.

Erythema. Reddened area of skin.

Erythematous. Area of skin reddened by congested blood vessels resulting from injury or inflammation.

Erythrocytes. Red blood cells.

Erythrocyte sedimentation test. A measure of general levels of inflammation in the body.

Erythropoiesis. Process of red cell formation that takes place in the red marrow of flat bones such as the sternum, hip bones, ribs, and skull bones.

Erythropoietin. Hormone synthesized principally by the kidney that stimulates red blood cell development.

Esophageal varices. Varicose veins of the esophagus.

Esophagitis. Inflammation of the esophagus caused by acid reflux.

Essential hypertension. High blood pressure with no known cause.

Essential trace minerals. Minerals required in the diet in very low amounts.

Estrogen. Sex hormone in females.

Etiology. Cause of a disease.

Exacerbation. Period of a chronic disease when signs and symptoms recur in all their severity.

Exocrine glands. Glands of external secretion that secrete mucus, perspiration, and digestive enzymes.

Exophthalmos. Condition in which the eyeballs protrude outward, characteristic of a person with Graves' disease.

Extradural. Hemorrhage between the dura mater and the skull.

Familial hypercholesterolemia. Autosomal dominant disorder caused by a mutation in the gene encoding the receptor for low-density lipoproteins.

Familial polyposis. Hereditary disease in which numerous polyps develop in the intestinal tract.

Fatty streaks. Thin deposits of lipids in artery walls.

Female arousal-orgasmic dysfunction. Lack of sexual desire or response in a female.

Fibrillation. Quivering or spontaneously uncoordinated contraction of muscle fibers, such as heart ventricles.

Fibroadenomas. Most common benign tumor of the breast.

Fibrocystic disease. Formation of numerous fluid-filled lumps in the breast.

Fibrous atheromatous plaques. Masses of lipid and scar tissue that narrow arteries.

Filiform warts. Warts around the mouth, nose, or beard area. The warts are the same color as skin with growths that look like threads sticking out of them.

Fimbriae. Fingerlike projections at the outer ends of the fallopian tubes that propel ova into the tube.

Flagella. Whiplike cell appendages used for locomotion.

Flagellates. Type of protozoa that move using whip-like flagella.

Flat warts. Small, pencil-eraser-size warts with flat tops that can be pink, light brown, or light yellow in color.

Flatus. Intestinal gas.

Flatworm. Wormlike animal that has a flattened body.

Flow cytometry. Identifies and counts cells that have a particular antigen.

Fluoroscopy. Diagnostic procedure that permits visualization of the lungs and diaphragm during respiration.

Follicle-stimulating hormone (FSH). Stimulates egg and sperm production.

Folliculitis. Superficial bacterial infection of the hair follicles caused by *Staphylococcus aureus* bacteria.

Fomite. Inanimate object or substance that can carry and transmit pathogens.

Foramen ovale. Small opening that allows blood from the right side of the heart to enter the left side directly, bypassing the nonfunctional fetal lungs.

Fragile X syndrome. Sex-linked disorder associated with mental retardation. It is identified by a break or weakness on the long arm of the X chromosome.

Free radicals. Molecules that may cause disease by injuring cells.

Friable. Easily broken nodules or vegetations.

Fulminating. Having a rapid or severe onset.

Functional obstructions. Condition is one in which there is no organic change.

Furuncles. Deep infections of the hair follicles, also known as boils.

Fusiform. Tubular shape, tapered at each end; type of aneurysm.

Galactosemia. Autosomal recessive disorder in which the enzyme necessary to convert galactose, a sugar derived from lactose in milk, to glucose is lacking.

Gamma-aminobutyric acid (GABA). Inhibitory neurotransmitter associated with various mental illnesses, sleep, mood, and behavior.

Gangrene. Condition in which bacteria infects and destroys dead tissue.

Gastric ulcers. Ulcers of the stomach.

Gastritis. Inflammation of the stomach caused by irritants such as aspirin, excessive coffee, tobacco, alcohol, or an infection.

Gastroesophageal reflux disease (GERD). Regurgitation of acidic stomach contents into the esophagus.

Gastroscopy. Procedure in which a camera is attached to a gastroscope photographing the entire inner stomach.

Genes. Found in chromosomes, each is responsible for the synthesis of one protein.

Genital herpes. Sexually transmitted infection caused by herpes simplex virus type 2.

Genital warts. Sexually transmitted infection caused by the human papillomavirus.

Gestational diabetes. Diabetes that develops during pregnancy.

Gigantism. Result of hypersecretion of growth hormone in children.

Glioblastomas. Highly malignant, rapid-growing tumors of the brain.

Glioma. Sarcoma of neuroglial tissue or glial cells.

Globin. Protein component of hemoglobin.

Glomerular capsule. Structure surrounding the glomerular capillaries of the nephron.

Glomerulonephritis. Degenerative inflammation of the glomerulus of a nephron, which usually follows a prior streptococcal infection.

Glomerulus. Tuft of capillaries situated inside the glomerular capsule of a nephron.

Glucagon. Hormone secreted by the pancreas that works antagonistically to insulin and is released when the blood sugar level falls below normal.

Glucocorticoids. Group of steroid hormones that helps regulate carbohydrate, lipid, and protein metabolism.

Glycogen. Form of glucose that is stored in the liver and muscle.

Glycosuria. Condition in which excess glucose is excreted in the urine, a major sign of diabetes mellitus.

Goiter. Enlargement of the thyroid gland.

Gonadotropins. Hormones of the anterior pituitary that regulate sexual development and function.

Gonorrhea. Sexually transmitted infection caused by *Neisseria gonorrhoeae*.

Gout. Condition characterized by attacks of acute inflammatory arthritis, it affects primarily the joints of the feet, particularly those of the big toe, and is very painful; also called gouty arthritis.

Gram stain. Staining technique that permits the identification of bacteria.

Graves' disease. Most common form of hyperthyroidism.

Greater vestibular glands. Glands that lie on either side of the vaginal entrance and produce a lubricating secretion during sexual intercourse.

Growth hormone (GH). Hormone that increases the synthesis of protein and promotes the growth of bone and tissues.

Gynecomastia. Condition in which the breasts become enlarged.

Hallucination. Seeing or hearing things that aren't there.

Haploid. The genetic condition of gametes (eggs or sperm), cells that have only one set of chromosomes, half of each pair of chromosomes, in contrast to diploid cells that possess two sets of chromosomes, one from each parent.

Health. Condition in which the human body performs its vital functions normally.

Heart block. Condition that prevents impulses from flowing from the atria to the ventricles, caused by a damaged route (e.g., a myocardial infarction), and resulting in an alteration of the heart rate and ECG.

Heart murmurs. Characteristic sounds of the heart that indicate the presence of valve defects.

Helicobacter pylori. Bacterium associated with ulcers.

Helper T cells. Cells that stimulate antibody production by plasma cells, increase phagocytosis, and stimulate cytotoxic T cells and natural killer cells.

Hemangioma. Benign tumor made of small blood vessels that form a red or purple birthmark.

Hematemesis. Vomiting of blood.

Hematocrit. Ratio of red blood cell volume to whole blood.

Hematoma. Bruise; a collection of blood outside the blood vessels, often caused by an injection.

Hematuria. Blood in the urine.

Heme. Organic iron-binding portion of hemoglobin.

Hemiplegia. Paralysis on one side of the body.

Hemodialysis. Treatment for kidney failure in which blood is removed from the body is cleansed of metabolic waste, restored to physiological balance, and returned to the body.

Hemoglobin. Protein containing iron; serves as the oxygen-carrier protein that enables red blood cells to carry oxygen from the lungs to all body tissues.

Hemoglobinopathy. Disorder arising from abnormal structure and function of hemoglobin.

Hemolysis. Rupture of erythrocytes.

Hemolytic streptococci. Type of bacteria that cause a variety of infectious diseases, including infections of the throat, skin, ear, and heart valves.

Hemolyze. Cause the rupture of erythrocytes.

Hemophilia. Sex-linked inherited coagulation disorder caused by a deficiency of clotting factors.

Hemoptysis. Coughing blood.

Hemorrhage. Large loss of blood in a short period of time, either internally or externally.

Hemorrhoids. Varicose veins of the rectum or anus.

Hemostasis. Reduced blood flow.

Hepatic coma. Profound unconsciousness that develops in the final stages of advanced liver disease; caused by an accumulation of ammonia in the blood, which has a toxic effect on the brain and may cause death.

Hepatocarcinoma. Cancer of the liver.

Hepatomegaly. Enlarged liver.

Hereditary hemorrhagic telangiectasia. Abnormal dilation of small vessels causing the appearance of

red-violet lesions on the face, lips, and oral and nasal mucosa.

Hermaphrodites. Individuals who have both testes and ovaries, a condition also called intersex.

Herniated discs. Bulging or ruptured intervertebral discs.

Heterozygous. Person having two different alleles of a certain gene.

Hiatal hernia. Protrusion of part of the stomach through the diaphragm at the point where the esophagus joins the stomach.

High-density lipoproteins (HDL). Smallest lipoprotein particles containing the smallest amount of triglycerides; “good” cholesterol.

Hippocampus. Structure of the brain that processes and stores information to memory.

Hirsutism. Condition in which excess hair develops on the face of a woman.

Histology. Study of cells.

Hodgkin’s lymphoma. Type of lymphoma distinguished by the presence of characteristic Reed-Sternberg cells in affected lymph nodes.

Homeostasis. Maintenance of relatively stable internal conditions under fluctuating environmental conditions.

Homozygous. Person having the same two alleles of a particular gene.

Hookworm. Intestinal parasitic roundworm.

Hordeolum. Infection of the sebaceous gland of the eyelid; a sty.

Horizontal transmission. Route by which an infectious disease is transmitted directly from an infected human to a susceptible human.

Hormones. Chemical messengers secreted by endocrine glands.

Human immunodeficiency virus (HIV). Causative agent of AIDS; a retrovirus—that is, it carries its genetic information as RNA rather than DNA.

Human papillomavirus (HPV). Virus responsible for warts and most cervical cancers.

Humoral immunity. Immune response provided by development of antibodies that counteract foreign antigens.

Huntington’s chorea. Progressive degenerative disease of the brain that results in the loss of muscle control.

Hydrocephalus. Accumulation of cerebrospinal fluid in the brain.

Hydrocortisone. Anti-inflammatory agent.

Hydrolithotripsy. Procedure using sonic vibrations to crush kidney stones while the patient is immersed in a tank of water.

Hydronephrosis. Condition when the kidney is extremely dilated with urine.

Hydroureters. Condition caused when the ureters above a kidney obstruction dilate.

Hyperactive. Condition in which a gland produces an excessive amount of its secretion.

Hypercalcemia. Excess calcium in the blood.

Hyperemesis gravidarum. Excessive vomiting during pregnancy.

Hyperglycemia. Excess glucose in the blood.

Hyperkalemia. Excess potassium in the blood, a condition that causes muscle weakness and can slow the heart rate to the point of cardiac arrest.

Hypernephroma. Carcinoma of the kidney; causes enlargement, and eventual destruction, of the kidney.

Hyperpituitarism. Condition associated with hypersecretion of the pituitary, usually manifested as the effects of excessive growth hormone, which retards the normal closure of bones at puberty.

Hypersensitivity. Extreme immune response to an antigen.

Hypertension. High blood pressure.

Hypertrophic cardiomyopathy. Disorder characterized by an enlarged heart.

Hypertrophy. Abnormal enlargement of an organ.

Hypoactive. Underactive. For example, a hypoactive gland is one that fails to secrete its hormone or secretes an inadequate amount.

Hypoalbuminemia. Albumin deficiency.

Hypochromic. Condition in which red blood cells appear lighter than normal, caused by an iron deficiency.

Hypophysis. Another name for the pituitary gland; has two parts, each of which acts as a separate gland.

Hypoplasia. Developmental failure leading to underdevelopment of a structure of tissue.

Hypothalamus. Homeostatic center for the body, located just superior to the pituitary; controls thirst, temperature, and other functions as well as release of pituitary hormones.

Hypothermia. Abnormally low body temperature resulting from prolonged exposure to cold air or water.

Hypovolemic shock. Results from fluid volume loss, for example after severe hemorrhage or loss of plasma in burn patients.

Hypoxia. Decreased concentration of oxygen in the blood from low oxygen availability or blockages that prevent oxygen from diffusing into the bloodstream.

Hysterectomy. Surgical removal of the uterus.

Hysteroscopy. Used to visualize the uterine lining.

Icterus. Jaundiced, yellow coloration.

Idiopathic. Describes a disease for which the cause is not known.

Idiopathic hypereosinophilic syndrome. Multisystem disease associated with persistent increases in blood eosinophils.

Immunity. Ability of the body to resist disease.

Immunoglobulin. Antibodies.

Impetigo. Acute, highly contagious bacterial skin infection that affects mainly infants and children.

Impotence. Inability to achieve and maintain an erection sufficient for sexual intercourse.

In situ. In position; not disturbing surrounding tissues.

Incidence. Rate of occurrence of new cases of a particular disease in a population being studied.

Incontinence. Inability to retain urine or feces from loss of sphincter control or because of cerebral or spinal lesions.

Infarct. Dead tissue that occurs from lack of blood flow in any organ or area, such as a coronary blockage in a heart vessel.

Infectious diseases. Diseases caused by pathogenic microorganisms.

Infestations. Infections involving wormlike animals called helminths.

Influenza. Acute, highly contagious respiratory infection.

Infundibulum. Connects the pituitary gland to the floor of the hypothalamus.

Initiation. First stage of cancer in which there is a genetic change in a cell, an altering of the DNA by some agent, chemical, radiation, or an oncogenic virus.

Insulin. Hormone that is secreted when the blood sugar level rises.

Insulin shock. Hypoglycemic shock that results from an imbalance caused by too much insulin, not enough food, or excessive exercise.

Intellectual disability. Significant limitations in intellectual functioning and adaptive behavior.

Interferon. Substance that stimulates nearby uninfected cells to produce substances that inhibit viral replication.

Intermittent claudication. Pain, numbness, fatigue in the lower leg, caused by impaired circulation in the veins.

Intrapleural pressure. Pressure within the pleural cavity.

Intravenous pyelogram. Procedure that allows the visualization of the urinary system by means of contrast dyes injected into the veins, followed by an x-ray examination.

Intrinsic factor. Substance produced in the stomach that carries vitamin B₁₂ to the small intestine, where it is absorbed into the bloodstream.

Intussusception. Type of organic obstruction in which a segment of intestine telescopes into the part forward of it.

In vitro research. Research conducted in a laboratory on parts of an organism isolated from its normal biological environment, sometimes called test-tube research, in contrast to *in vivo* research conducted on living subjects.

Irritable bowel syndrome. Functional condition of the colon with diarrhea, constipation, abdominal pain, and gas.

Irritable colon. Functional disorder of the colon that results in diarrhea and cramping.

Ischemia. Deficiency of blood supply to any organ.

Isolation. Keeping an infected person in the hospital or at home and not in contact with other persons as a way of controlling the transmission of infectious diseases.

Jaundice. Yellow-orange discoloration of the skin, tissues, and the whites of the eyes caused when bilirubin (an orange pigment) accumulates in the plasma.

Kaposi's sarcoma. Purple neoplasm of the lower extremities.

Karyotype. Normal chromosomal composition of the nucleus of the cell that is characteristic of each species.

Keloid. Healing that occurs after surgery or a severe burn, consisting of a hard, raised scar.

Kidney dialysis. Treatment for kidney failure; removes metabolic waste from blood and restores it to physiological balance.

Klinefelter's syndrome. Condition affecting males in which there is an extra X chromosome resulting in a karyotype of 47,XXY and who, in adulthood, may have few differences from other males or may have some immature male and some female characteristics such as small testes and enlarged breasts.

Kupffer cells. Specialized cells that line the blood spaces within the liver. They engulf and digest bacteria and other foreign substances, thus cleansing the blood.

Kwashiorkor. Protein-calorie malnutrition that results from early weaning from breast milk.

Kyphosis. Abnormal forward curvature of the upper spine sometimes called roundback, hunchback, or humpback.

Labia majora. Outer vaginal lips.

Labia minora. Inner vaginal lips.

Laparoscopy. Minimally invasive surgery, sometimes called keyhole or bandaid surgery, in which a laparoscope, a fiberoptic instrument, inserted into the

abdomen through a small incision is used to visualize female reproductive organs or other structures in the abdominal cavity.

Larynx. An organ of the respiratory system located at the entrance of the trachea that contains the vocal cords; sometimes called the voice box.

Latent infection. Condition caused when viruses insert themselves in cells and do not reproduce.

Legionnaire's disease. Lung infection caused by the bacterium *Legionella pneumophila*; characterized by flulike symptoms.

Leiomyomas. Benign tumors of the smooth muscle of the uterus, known as fibroid tumors.

Lentigines. Type of freckle that develops in older adults; often called liver spots or age spots.

Lesion. Abnormal tissue structure or function. May be the result of a wound, injury, or pathologic condition.

Lethargy. Condition of drowsiness or lack of energy.

Leukemia. Cancer of white blood cells in which the bone marrow produces a large number of abnormal white blood cells.

Leukocoria. An abnormal white reflection from the retina.

Leukocytes. White blood cells.

Leukocytosis. Excessive production of white cells.

Leukorrhea. White, foul-smelling vaginal discharge.

Ligament. Fibrous tissue that holds connects bones to other bones.

Lipase. Digestive enzyme that breaks down lipid or fat.

Lipoma. Tumor that develops in adipose or fat tissue.

Lipoprotein. Water-soluble lipid fat. It is packaged into particles that contain blood proteins, which do mix with water.

Lithotripsy. Procedure using sonic vibrations to crush kidney stones; the patient is not immersed in water for the procedure.

Lordosis. Abnormal forward curvature of the lower spine sometimes called swayback.

Low-density lipoproteins (LDL). Larger lipoprotein particles containing triglycerides; "bad" cholesterol.

Lumbar. Of or relating to the lower back.

Lumbar puncture. Procedure in which a hollow needle is inserted into the spinal canal between vertebrae near the L-4, or lumbar, region to obtain and analyze cerebrospinal fluid; also known as a spinal tap.

Lumen. Inner space of a hollow organ such as a blood vessel or intestine.

Lumpectomy. Surgery to remove only the tumor from the breast.

Lupus. Chronic autoimmune disease that can affect various parts of the body, including the skin, joints, heart, lungs, blood, kidneys, and brain.

Luteinizing hormone (LH). Hormone that stimulates the production of sex hormones; LH surge causes ovulation.

Lymphadenopathy. Enlarged lymph nodes.

Lymphocytes. A type of white blood cell consisting of T lymphocytes and B lymphocytes.

Lymphocytic. Type of leukemia that results from cancer of the lymphocytic stem cells, found in both the bone marrow and the lymph nodes.

Lymphoma. Malignancy of the lymphatic system.

Lyse. Cause the destruction of a cell.

Macule. Discolored spot on the skin; also called a freckle.

Magnetic resonance imaging (MRI). Diagnostic-imaging technique that uses the behavior of protons when placed in powerful magnetic fields to make images of organs and tissues.

Major depressive disorder. Unrelenting sense of hopelessness and despair that is disabling and prevents one from functioning normally.

Malabsorption syndrome. Inability of a person to absorb substances from the small intestines.

Malignant. Tending to grow or spread, as a tumor that invades surrounding tissue and may metastasize, or spread to other parts of the body.

Malnutrition. Suboptimal supply of nutrients that results in decreased tissue mass and energy stores needed for proper growth and development.

Mammography. Diagnostic x-ray for breast tissue that can detect small, early cancers.

Marfan syndrome. Autosomal dominant inherited disorder that involves dysfunction of the gene that codes for the connective tissue protein fibrillin.

Marasmus. Protein-calorie malnutrition caused by near starvation.

Mastectomy. Surgery to remove the breast, usually because of cancer.

Mastoiditis. Inflammation of the air cells in the mastoid process of the temporal bone.

Medullary cavity. Hollow cavity found in the long bones of the arms and legs that is filled with yellow bone marrow primarily consisting of fat.

Melanoma. Uncommon but dangerous skin cancer that begins in the melanocytes, the cells that produce the pigment melanin.

Melasma. Patches of darker skin on the face, especially over the cheeks.

Melena. Stool with a dark, tarry appearance caused by blood from the upper part of the digestive tract.

Memory cells. Lymphocytes produced in response to an infection that persist in the body, ready to respond to a subsequent infection by the same antigen.

Menarche. Onset of menstruation.

Meniere's disease. Condition of the inner ear associated with loss of the sense of balance.

Meninges. Coverings that protect the delicate nerve tissue of the spinal cord and brain.

Meningioma. Benign tumor that occurs in the membranes that surround the brain.

Meningitis. Acute inflammation of the first two meninges that cover the brain and spinal cord.

Meningocele. Form of spina bifida in which the meninges but not the spinal cord itself protrudes through an opening.

Meningomyelocele. Form of spina bifida in which the meninges and spinal nerves protrude through an opening; nerve elements that protrude into the sac and are trapped, thus preventing proper placement and development.

Menopause. Cessation of menstrual periods, the ending of a woman's reproductive years; usually begins in the late 40s or early 50s.

Menorrhagia. Excessive or prolonged bleeding during menstruation.

Mental health. Condition of being sound mentally and emotionally that is characterized by the absence of mental disorder and by adequate adjustment to the demands of life.

Mesothelioma. Cancer of the membrane that covers and protects most of the internal organs of the body.

Metastasis. Spread of cancer within the body.

Metrorrhagia. Bleeding between menstrual periods or extreme irregularity of the cycle.

Microbiota. Normal population of microorganisms associated with the human body.

Micturition. Urination reflex.

Mineralocorticoids. Group of steroid hormones that regulate salt balance in the body.

Mitral stenosis. Occurs when opening of the mitral valve in the heart is too small and the cusps that form the valve become rigid and fuse together.

Mitral valve. Valve between the left atrium and left ventricle of the heart; it has two flaps, or cusps, that meet when the valve is closed.

Mixed cancers. Cancer consisting of cells of different origins or tissue types.

Monocyte. Type of white blood cell that engulfs bacteria and damaged tissue.

Mons pubis. Fat pad that covers the pubic bone; it becomes covered with hair at puberty.

Morbidity. Incidence of disease. *See* Incidence.

Mortality. Number of deaths attributed to a disease in a given time or place.

Mucosa. Moist tissue that lines some parts of the body and secretes a slippery substance called mucus. Secretion of excessive nasal mucus causes a runny nose and congestion.

Mucus. Slippery secretions from the mucous membranes; can be thick or watery.

Multifactorial. Having multiple factors or causes, as with diseases and disorders caused by a combination of genes, environment, and behavior.

Muscular dystrophy (MD). Disorder of skeletal muscle protein.

Mutagens. Chemicals introduced to the lungs by cigarette smoking.

Myasthenia gravis (MG). Autoimmune neuromuscular disorder characterized by muscular fatigue that develops with repetitive muscle use and improves with rest.

Mycelia. Filaments in fungi specialized for absorption of nutrients.

Mycoses. Infectious diseases caused by fungi.

Myelin. Lipid covering that insulates the fibers of sensory and motor neurons.

Myelocoele. Most severe form of spina bifida.

Myelogenous. Type of leukemia in which the cancer originates in the bone marrow.

Myelomonocytic leukemia. Type of myelogenous leukemia of malignant monocytes.

Myocardial infarction. Heart attack.

Myocardium. Cardiac muscle found in the chamber walls of the heart.

Myoma. Tumor of the muscle that develops in smooth or involuntary muscle.

Myopia. Visual defect in which distant objects appear blurred because their images are focused in front of the retina rather than on it.

Natural killer cells. Leukocytes that destroy cells with abnormal membranes.

Necrotic. Dead. Necrotic tissue is caused by lack of blood flow to the area.

Negative-feedback mechanism. Decrease in function in response to a stimulus. For example, the secretion of follicle-stimulating hormone decreases as the amount of circulating estrogen increases.

Neoplasm. Abnormal growth of tissue that is a result of uncontrolled cell growth.

Nephron. Functional unit of the kidney.

Neurogenic bladder. Condition in which the nerves of the urinary system don't work properly when the bladder is full and may allow urine leakage.

Neurogenic shock. Condition caused by generalized vasodilation resulting from decreased vasomotor tone.

Neurohypophysis. Posterior lobe of the pituitary gland.

Neuron. Nerve cell.

Neurotransmitter. Chemical messengers that communicate in the synapse between nerve cells, or neurona.

Neutropenia. Reduction of circulating neutrophils, or white blood cells.

Neutrophils. White blood cells that fight against invading agents or injury.

Nevus. Small, dark skin growth that develops from melanocytes.

Nitroglycerin. Medication used to dilate coronary arteries, permitting adequate blood flow.

Nocturia. Urination at night, especially when excessive.

Noncommunicable. Infectious diseases that are not transmitted directly by humans.

Nondisjunction. Failure of two chromosomes to separate as the gametes, either the egg or the sperm, are being formed.

Non-Hodgkin's lymphoma. Cancer of the lymphocytes.

Nonspecific immunity. Immunity that is present at birth and provides immediate, short-term protection against any antigen.

Norepinephrine. Neurotransmitter of the sympathetic nervous system.

Normal flora. Microorganisms normally associated with the human body.

Nosocomial. Associated with hospital personnel, procedures, or equipment.

Nosocomial infections. Infectious diseases transmitted by medical personnel, procedures, or equipment.

Notifiable diseases. Diseases under surveillance that must be reported by physicians to the Centers for Disease Control and Prevention.

Nucleic acid analogues. Antiviral medications.

Nutrient. Chemical compound consumed in food that is required for vital cellular processes.

Nystagmus. Involuntary, rapid movement of the eyeball, characteristic of multiple sclerosis.

Obesity. Nutritional disorder in which an abnormal amount of fat accumulates in adipose tissue.

Obesity-hypoventilation syndrome. Condition of recurrent episodes of apnea during sleep caused by airway occlusion from excess weight or obesity; also called pickwickian syndrome.

Obstructions. Blockages of the intestines.

Occult blood. Blood detected in stool by means of a chemical test but not apparent to the naked eye.

Oliguria. Reduced production of urine.

Oncogene. Any gene having the potential to induce a cancerous transformation.

Orchitis. Inflammation of the testes.

Organic obstructions. Material blockage that prevents the contents of the intestinal tract from moving forward.

Ossification. Process by which bone tissue is formed.

Osteitis deformans. Chronic disease characterized by enlarged and misshapen bones; also called Paget's disease.

Osteitis fibrosa cystica. Bone disease characterized by fibrous nodules and cysts and porous decalcified bone.

Osteoarthritis. Most common form of arthritis, a chronic disease that accompanies aging and may affect only one joint.

Osteoblasts. Cells that work within the bone to form bone tissue.

Osteoclasts. Cells that work within the bone and resorbs bone.

Osteocytes. Mature cells in bone tissue.

Osteogenic sarcoma. Primary malignancy of the bone.

Osteoma. Most common benign tumor of the bone.

Osteomalacia. Bone disease in adults caused by the lack of vitamin D, which results in a softening of the bones.

Osteomyelitis. Inflammation of the bone, particularly of the bone marrow in the medullary cavity and in the spaces of spongy bone.

Osteoporosis. Increased porosity of the bone.

Outbreak. Sudden occurrence of a disease, in unexpected numbers in a limited area, which then subsides.

Oxytocin. Stimulates uterine contractions, milk release, and ejection of prostate gland secretions.

Paget's disease. Chronic disease characterized by enlarged and misshapen bones. *See* Osteitis deformans.

Pallor. Pale skin.

Palpitations. Irregular heartbeat.

Pancreatic islets. Endocrine cells of the pancreas.

Pancreatitis. Potentially life-threatening inflammation of the pancreas.

Pandemic. Epidemic that has spread to include several large areas worldwide.

Pap smear. Diagnostic technique for identifying cancer in the cervix by scraping cells from the cervix and examining them microscopically.

Papanicolaou test. Screening test for cervical cancer based on observations of cells obtained in biopsies of the cervix.

Papilloma. Epithelial tumor that grows as a projecting mass on the skin or from an inner mucous membrane. Also known as a polyp. The common wart is an example.

Papule. Solid elevated area on the skin (pimple).

Paralytic obstructions. Decrease in peristalsis, preventing propulsion of intestinal contents.

Parathormone. Hormone secreted by the parathyroids.

Parathyroid hormone (PTH). Increases the calcium concentration in blood.

Parenteral. Delivered through a route other than mouth or rectum (which are enteral routes). Delivery of nutrients or medication by infusion into a vein is an example of parenteral delivery.

Paresis. General paralysis associated with organic loss of brain function; results in death if untreated.

Paresthesia. Numbness, burning, or tingling sensation resulting from nerve injury.

Passive immunity. Immunity transmitted through doses of preformed antibodies from immune serum of an animal, usually a horse. This type of immunity is short-lived but acts immediately.

Patent ductus arteriosus (PDA). Common congenital disease in which the ductus arteriosus remains open and blood intended for the body flows from the aorta to the lungs, overloading the pulmonary artery.

Pathogen. Microorganism that causes disease.

Pathogenesis. Source or cause of an illness or abnormal condition and its development.

Pathologist. Physician who interprets and diagnoses the changes caused by disease.

Pathology. Study of disease, especially the structural and functional changes produced by them.

Pediculosis. Infestation of lice.

Pellagra. Niacin deficiency.

Pelvic inflammatory disease (PID). Infection of the uterus, fallopian tubes, and other reproductive organs.

Peptic ulcers. Ulcers of the stomach and small intestine resulting, in part, from the action of pepsin, a proteolytic enzyme secreted by the stomach.

Perforation. Ulcer that breaks through the intestinal or gastric wall, causing sudden and intense abdominal pain.

Pericardium. Double membranous sac that encloses the heart.

Perineum. Space between the rectal opening and the vaginal opening.

Periosteum. Highly vascular layer of fibrous connective tissue that covers the surface of bones.

Peripheral vascular disease. Atherosclerosis or arteriosclerosis of noncoronary arteries.

Peristalsis. Muscle contractions that propel food during the digestive tract.

Peritoneal dialysis (PD). Treatment for kidney failure; fluid added to the peritoneal cavity draws metabolic waste from the blood and restores it to physiologic balance.

Peritonitis. Inflammation of the lining of the abdominal cavity. Usually results when the digestive contents enter the cavity because this material contains numerous bacteria.

Periungual warts. Warts around toenails or finger nails. The warts are rough bumps with an uneven surface and border.

Pernicious anemia. Anemia caused by a vitamin B₁₂ deficiency.

Personality disorders. Deeply ingrained, inflexible pattern of relating, perceiving, and thinking serious enough to cause distress or impaired functioning.

Petechiae. Tiny red or purple spots caused by minute blood vessels that rupture in the skin.

Phagocyte. Leukocyte that engulfs and destroys foreign material.

Phagocytosis. Process of a cell engulfing and destroying foreign material.

Pharyngeoplasty. Surgical removal of the uvula to alleviate obstructive sleep apnea.

Pharynx. Throat.

Phenylketonuria (PKU). Caused by an autosomal recessive allele that lacks a specific enzyme that converts one amino acid, phenylalanine, to another, tyrosine.

Pheochromocytoma. Neuroendocrine tumor of the adrenal gland.

Phlebitis. Inflammation of a vein, usually in the leg.

Phosphate. Compound containing phosphorous essential for bone and tooth structure as well as cell physiology.

Pipestem colon. Describes the colon in patients suffering from chronic ulcerative colitis; colon appears straight and rigid.

Placenta. Interdigitation of embryonic and maternal tissue.

Plantar warts. Painful warts that form on the soles of the feet.

Plaque. Fatty deposits in the walls of arteries.

Plasma. Fluid component of blood.

Plasma cells. Cells that develop from B cells and produce antibodies.

Platelets. Clotting elements of blood.

Pleura. Double membrane consisting of two layers that encase the lungs.

Pleural cavity. Space between the two layers of the pleura containing a small amount of fluid that lubricates the surfaces, preventing friction as the lungs expand and contract.

Pleurisy. Inflammation of the pleural membranes that line the chest wall and encase each lung.

Pneumonia. Infection in one or both lungs affecting primarily the alveoli.

Pneumothorax. Collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse.

Poliomyelitis. Infectious disease of the brain and spinal cord caused by a virus.

Polycythemia vera. Elevated erythrocyte level.

Polydactyly. Autosomal dominant inherited disorder that causes extra fingers or toes.

Polydipsia. Extreme thirst.

Polymorphs. White blood cells specialized to fight against invading agents or injury.

Polyp. Benign epithelial tumor.

Polyphagia. Excessive hunger.

Polyuria. Excessive production of dilute urine.

Postherpetic neuralgia. Inflammation and pain in nerves following herpes virus infection.

Preeclampsia. High blood pressure and excess protein in the urine after 20 weeks of pregnancy in a woman who previously had normal blood pressure.

Prehypertension. Persistently high normal blood pressure; raises risk for hypertension.

Premature ejaculation. Ejaculation during foreplay or immediately after beginning intercourse.

Premenstrual dysphoric disorder. Subcategory of depression with cyclical symptoms that occur prior to menstruation.

Premenstrual syndrome (PMS). Emotional, physical, and behavioral symptoms that are associated with the menstrual cycle.

Pressure ulcer. Area of unrelieved pressure, usually over a bony prominence, resulting in a reduction in bloody supply to that area, causing death of cells and tissue.

Prevalence. Percentage of a population that is affected with a particular disease at a given time.

Primary adrenal insufficiency. Result of undersecretion of hormones by the adrenal cortex.

Prion. Infectious protein particle; cause of Creutzfeldt-Jakob disease.

Proctoscope. Instrument consisting of a hollow tube with a lighted end used by physicians to observe the lining of the colon.

Prognosis. Predicted course and outcome of a disease.

Progression. Third stage of cancer development.

Prolactin. Protein that stimulates breast development and milk production.

Prolapse. Falling or dropping down of an organ or internal structure, such as the uterus or rectum.

Promotion. Second stage of cancer development in which altered cells proliferate and resemble benign neoplasms, which can either regress to normal-appearing tissue or evolve into cancer.

Prostate gland. Gland that secretes a thin, milky fluid that enhances sperm motility and neutralizes the acidity of the male urethra and of the woman's vagina.

Prostatitis. Inflammation or infection of the prostate.

Prothrombin. Enzyme synthesized by the liver with the aid of vitamin K that initiates the chain reaction in the blood-coagulation process.

Pruritus. Itching that accompanies many skin diseases.

Pseudopodia. Cell membrane extensions used for locomotion of phagocytosis.

Pseudohermaphrodites. Persons with the condition of ambiguous gender, also called intersex.

Psoriasis. Chronic skin disease characterized by scaling and inflammation.

Psychology. Study of human behavior.

Psychosis. Loss of contact with reality.

Puerperal mastitis. Bacterial infection of the breast.

Puerperal sepsis. Infection of the endometrium after childbirth or an abortion.

Puerperium. Time period after childbirth when the endometrium is open and particularly susceptible to infection.

Pulmonary edema. Buildup of fluid in the lungs, causing shortness of breath.

Pulmonary embolism (PE). Blockage in one or more arteries of the lungs.

Pulmonary stenosis. First cause of cyanosis in which the valve opening that leads into the pulmonary artery is too small and an inadequate amount of blood reaches the lungs to be oxygenated.

Purkinje fibers. Specialized heart tissue that conducts the impulse for contraction to the myocardium of the ventricles.

Purpura. Small hemorrhages into the tissue beneath the skin or mucous membranes.

Purpura simplex. Condition of easy bruising.

Pustule. Small, elevated lesion filled with pus.

Pyelitis. Inflammation of the renal pelvis, the juncture between the ureter and the kidney, caused by *E. coli* or other pus-forming bacteria.

Pyelonephritis. Suppurative inflammation of the kidney and renal pelvis.

Pyloric sphincter. Sphincter muscle through which food passes from the stomach into the small intestine.

Pyloric stenosis. Congenital obstruction of the intestinal tract.

Pyuria. Condition caused when abscesses in the kidney rupture and pus enters the renal pelvis and then appears in urine.

Quarantine. Separation of persons who may or may not be infected from healthy people until the period of infectious risk is passed.

Rabies. Infectious disease of the brain and spinal cord caused by a virus that is transmitted by the saliva, urine, or feces of an infected animal.

Raynaud's disease. Condition in which small arteries or arterioles in the fingers and toes constrict. If it occurs alone it is known as Raynaud's disease. If it occurs with another condition it is known as secondary Raynaud's phenomenon.

Recessive. Describes a trait that becomes manifest only only in a person who is homozygous for the trait, meaning that both copies of the responsible gene, called alleles, the one from the person's father and the one from the mother, have the same mutation that produces that trait. If the person has only one allele with that mutation, from either the father or the mother, the trait does not develop.

Rectoceles. Bulging of the front wall of the rectum into the vagina.

Reemerging infectious disease. Disease increasing in prevalence after being uncommon.

Reflux. Backflow of the acid contents of the stomach causing inflammation of the esophagus.

Regional enteritis (Crohn's disease). Inflammatory disease of the intestine that most frequently affects young adults, particularly females.

Regurgitation. Passage of stomach contents into the esophagus.

Relapse. Return of a disease weeks or months after its apparent cessation.

Remission. The period of a chronic disease when signs and symptoms subside.

Renal failure. Complete loss of kidney function in the final stages of renal disease.

Renal pelvis. Juncture between the kidneys and the ureters; final urine from all collecting ducts empties here.

Renin. Enzyme secreted by cells that converts angiotensinogen to angiotensin in a body system that regulates blood pressure.

Reservoirs. Sources of a pathogen and potential sources of disease.

Respiratory epithelium. Mucous membrane that lines the entire respiratory tract.

Restrictive cardiomyopathy. Reduced cardiac blood-pumping ability.

Resuscitation. Assisting or reviving respiration to a person with a myocardial infarction.

Reticulocyte. Late stage of erythrocyte development.

Reye's syndrome. Potentially devastating neurologic illness that sometimes develops in young children after a viral infection.

Rhabdomyosarcoma. Malignant tumor of the skeletal muscle.

Rheumatoid factor. Antibodies in blood associated with rheumatoid arthritis.

Rhodopsin. Pigment that absorbs light in the rods of the retina.

Rickets. Disease of infancy and early childhood in which the bones do not properly ossify, or harden, generally caused by a vitamin D deficiency.

Rosacea. Inflammatory skin disorder that causes facial erythema (redness).

Roundworm. A wormlike animal that is relatively round in cross section.

Saccular. Balloon-shaped aneurysm.

Sacral. Of or relating to the sacrum, the fused bones at the end of the spine.

Salpingitis. Inflammation of the fallopian tubes.

Sarcoma. Type of cancer affecting the supportive tissue such as muscle, bone, and cartilage.

Scabies. Parasitic mite skin disease usually associated with poor living conditions.

Schizophrenia. Mental disorder that distorts the way a person thinks, acts, expresses emotions, perceives reality, and relates to others.

Scleroderma. Chronic autoimmune disease of the connective tissue.

Sclerosis. Abnormal hardening of a tissue.

Sclerotherapy. Use of sclerosing or hardening agents to treat diseases such as hemorrhoids or esophageal varices.

Scoliosis. Lateral curvature of the spine.

Scurvy. Disease caused by vitamin C deficiency.

Seborrheic dermatitis. Chronic inflammatory skin disorder generally affecting areas of the head and trunk where sebaceous glands are prominent.

Seborrheic keratosis. Benign overgrowth of epithelial cells; the most common benign tumor in older individuals.

Sebum. Oily fluid released through the hair follicles.

Secondary hypertension. High blood pressure that results from an underlying primary disease or disorder.

Seizures. Uncontrolled nervous system activity manifested by uncoordinated motor action.

Seminal vesicles. Glands behind the male bladder that secrete a thick, yellowish fluid that nourishes and activates the sperm.

Seminiferous tubules. Highly coiled tubules contained within the testes in which sperm develop.

Septic embolism. Embolism that contains infected material from pyogenic bacteria.

Sequela. Aftermath of a particular disease, such as permanent damage to the heart after rheumatic fever.

Sex chromosomes. The X and Y chromosomes that determine an individual's biological sex.

Sex-linked inheritance. Diseases transmitted on the sex chromosomes.

Serum. Liquid portion of the blood.

Shingles. Acute inflammation of nerve cells caused by the chickenpox virus, herpes zoster.

Sickle cell anemia. An autosomal recessive inherited disorder in which hemoglobin is abnormal, resulting in deformed, sickle-shaped red blood cells.

Signs. Objective evidence of disease observed on physical examination, such as abnormal pulse or fever.

Sinoatrial node. Pacemaker of the heart, it is a small patch of tissue at the top of the atrium of the heart that initiates the heartbeat.

Sjögren's syndrome. Chronic, slowly progressive autoimmune disease that affects the exocrine glands of the body.

Skeletal muscle. Striated muscle attached to bone and that is under conscious control.

Somatic. Physical. Something that happens physically rather than mentally. Or it may refer to a false belief that something physical is occurring in one's body.

Somatostatin. Hormone that inhibits the secretion of glucagon and insulin.

Spastic colon. Functional condition of the colon with diarrhea and cramping. Also called irritable colon.

Specific immunity. Immunity that responds to the presence of specific antigens and develops in response to contact with those antigens.

Spider veins. Small, dense, red networks of veins close to the skin surface.

Spina bifida. Condition in which one or more vertebrae fail to fuse, leaving an opening in the vertebral canal.

Spirilla. Spiral-shaped bacterial cells.

Spirochetes. Corkscrew-shaped bacterial cells.

Spirometry. Diagnostic procedure that measures and records changes in gas volume in the lungs, determining ventilation capacity and flow rate.

Splenectomy. Surgical removal of the spleen.

Splenomegaly. Enlarged spleen.

Spongy bone. Bone tissue with blood-filled spaces; found at ends of bones or in flat bones such as those of the skull.

Spores. Microscopic fungal reproductive structures that can induce allergies.

Sporozoans. Form of protozoa; single-celled, immobile, eukaryotic microorganisms.

Sprain. Result of the wrenching or twisting of a joint such as an ankle that injures the ligaments.

Spurs. Spicules of abnormal new bone development.

Squamous cell carcinoma. Second most common form of skin cancer; develops in any squamous epithelium of the body.

Staghorn calculus. Kidney stone that becomes so large it fills the renal pelvis completely, blocking the flow of urine.

Standard precautions. Precautions such as gloves required of medical personnel when handling patients or bodily fluids.

Stasis. Slow blood flow that may lead to thrombosis or cause infection; slow urine flow that may promote kidney stones.

Stenosis. Constriction or narrowing of a passage or orifice.

Stent. Rigid structure surgically inserted into arteries in order to hold them open.

Stomatitis. Inflammation of the lining of the mouth often caused by bacteria or fungi.

Strabismus. Crossed eyes.

Strains. Pulled muscles that result from a tearing of a muscle and/or its tendon from excessive use or stretching.

Streptococci. Type of bacteria associated with infections of the ear, throat, skin, and heart valves.

Stridor. High-pitched breath sound.

Stroke. Cerebral hemorrhage or blood-clot formation within cerebral blood vessels.

Stye. Red, tender bump on the eyelid that is caused by an acute infection of the oil glands of the eyelid. See hordeolum.

Subarachnoid. Tear in the surface membrane of the brain, caused by a skull fracture.

Subdural. Hemorrhage under the dura mater from large venous sinuses of the brain rather than an artery.

Supraventricular arrhythmia. Irregular heart rhythm originating from or above the sinoatrial node, the heart's pacemaker.

Symptoms. Indication of disease perceived by the patient, such as pain, dizziness, and itching.

Syncope. Fainting caused by insufficient blood supply to the brain.

Syndrome. A group of signs and symptoms that occur together and characterize a particular disease.

Synovial fluid. Lubricating and shock-absorbing fluid found within joints.

Synovial membrane. Membrane that lines the joints.

Syphilis. Sexually transmitted infection caused by *Treponema pallidum*.

Systole. Period of the heartbeat when the heart contracts and pumps the blood.

Systolic. Pertaining to the systole, the contractive stage of heart cycle.

T cell. Lymphocyte that provides cell-mediated immunity.

Tachycardia. Heart rate of 100 beats per minute or more; a fast heart rate.

Tachypnea. Rapid respiration rate.

Tay-Sachs disease. Autosomal recessive inherited disorder caused by the absence of the Hex A enzyme.

Tendons. Connective tissue that attaches skeletal or voluntary muscles firmly to bones.

Terminal. Resulting in death, as in a terminal disease.

Tetanus toxoid. Type of immunization that protects from the disease tetanus.

Tetany. Sustained muscular contraction.

Tetralogy of Fallot. One of the most serious congenital heart defects consisting of four (*tetra*) abnormalities.

Thalassemia. Group of inherited blood disorders in which there is deficient synthesis of one or more alpha or beta chains required for proper formation and optimal performance of the hemoglobin molecule.

Thoracic. Of or relating to the thorax.

Thoracic aneurysm. Balloon-like bulge in the thoracic aorta.

Thrombi. Blood clots.

Thrombocytopenia. Disease of platelets resulting in gastrointestinal and urogenital hemorrhages as well as severe nosebleeds.

Thrombolytic. Agents that dissolve blood clots.

Thrombophlebitis. Thrombus formation in deep veins.

Thrombosis. Forming of blood clots on blood vessel walls.

Thrombus. Blood clot that forms in a blood vessel.

Thyroid-stimulating hormone (TSH). Hormone that stimulates the production of the thyroid hormones.

Thyroxine. One of the thyroid hormones.

Tinea. Superficial fungal infection also known as ringworm.

Tinea barbae. Barber's itch. Deep, inflammatory pustules and crusting around bearded areas of the face and neck.

Tinea capitis. Scalp ringworm. Single or multiple patches of hair loss with a black dot pattern, inflammation, scaling, pustules, and pruritus.

Tinea corpora. Body ringworm. Ring-shaped rash with a red-colored raised border and a clearer center.

Tinea cruris. Jock itch. Red, ringlike areas with vesicles.

Tinea pedis. Athlete's foot. Scales and fissures on the soles of the feet and between the toes.

Tinea unguium. Nail fungus. White patches that eventually turn the nail brown; thickening and cracking of the nail.

Toxic shock syndrome (TSS). Potentially fatal illness caused by infection with *Staphylococcus aureus*.

Toxoid. Chemically altered toxin that stimulates an immune response.

Trachea. Tubular structure that connects the larynx to the primary bronchi of the lungs. Sometimes called the windpipe.

Tracheotomy. Emergency procedure to maintain airway by cutting a hole in the trachea.

Trachoma. Chronic contagious form of conjunctivitis causing hypertrophy of the conjunctiva.

Transformation. Change from one tissue to another.

Transient ischemic attack (TIA). A minor, self-correcting stroke. Often the precursor to an actual stroke.

Tremor. Shakiness, particularly of the hands.

***Trichomonas vaginalis*.** Parasite that can be transmitted by sexual intercourse; one causative agent of vaginitis.

Trichomoniasis. Sexually transmitted infection caused by *Trichomonas vaginalis*.

Tricuspid valve. Three-cusped valve between the right atrium and right ventricle.

Triglycerides. Lipid fats that are not water-soluble and therefore cannot mix with blood plasma.

Triiodothyronine. A thyroid hormone.

Trismus. Inability to open the jaws caused by muscle spasms or rigidity as may occur in tetanus.

Trisomy 21. Condition of having three, rather than two, copies of chromosome 21; causes Down syndrome.

Tropic hormones. Prolactin, growth hormone, adrenocorticotrophic hormone, luteinizing hormone, follicle-stimulating hormone, and thyroid-stimulating hormone; collectively called tropic hormones because they control the function of other endocrine glands.

Tubercles. Lesions formed when tissue infected with tuberculosis heals with fibrosis and calcification, walling off the bacteria for months or many years.

Tuberculosis (TB). Potentially fatal contagious disease that can affect almost any part of the body but is most commonly an infection of the lungs.

Tumor. Abnormal growth of cells that is a result of uncontrolled cell growth.

Tumor marker. Abnormal levels or substances found in the blood of cancer patients; used to monitor the presence of cancer and the extent of disease.

Turner's syndrome. Condition caused when one of the sex chromosomes is missing, resulting in a karyotype of 45,XO.

Type 1 diabetes mellitus (T1DM). Diabetes mellitus is a disease that causes high blood glucose. Type 1 diabetes is characterized by little or no insulin production.

Type 2 diabetes mellitus (T2DM). Diabetes mellitus characterized by the body's resistance to the effects of insulin or by the body not producing enough insulin to maintain a normal glucose level.

Ulcer. An area of the skin or other body membrane in which the surface has eroded.

Ultrasound. Imaging technique utilizing low-frequency sound waves.

Ultrasound cardiography. Ultrasound imaging technique that shows the anatomy of arteries, particularly the carotid bifurcation and the internal carotid artery.

Urea. Nitrogen-containing waste products formed in the liver.

Uremia. Toxic condition of blood; the end result is kidney failure.

Ureter. Muscular tube that passes urine from the kidney to the urinary bladder.

Ureterocele. Cystlike dilation of the ureter near its opening to the urinary bladder.

Urethra. Single tube through which urine empties to the outside from the urinary bladder.

Urethritis. Inflammation of the urethra.

Urinalysis. Simple diagnostic procedure that examines a urine specimen physically, chemically, and microscopically.

Urinary calculi or uroliths. Stones formed primarily in the kidney when certain salts in the urine form a precipitate and grow in size.

Urodynamic testing. Assesses how well the bladder and urethra are storing and releasing urine.

Urticaria. Also called hives; results from a vascular reaction of the skin to an allergen.

Uterine prolapse. Falling or sliding of the uterus from its normal position in the pelvic cavity into the vaginal canal.

Uvula. Soft structure hanging from the free edge of the soft palate in midline above the root of the tongue.

Uvulopalatopharyngoplasty (UPPP). Procedure that removes excess tissue in the throat (uvula and pharynx) to widen the airway.

Vaccine. Low dose of dead or deactivated bacteria or virus that stimulates an immune response.

Valvular insufficiency. Condition characterized by a valve opening that is too large and does not prevent backflow.

Vasopressin. One of two hormones secreted by the posterior pituitary; also called antidiuretic hormone.

Vectors. Animals that transmit pathogenic microorganisms to humans.

Vegetations. Small nodular structures composed of bacteria and clots that form along the edge of cusps in a valve opening.

Venae cavae. Two largest veins of the body: the superior vena cava that returns deoxygenated blood from the upper body to the heart and the inferior vena cava that returns deoxygenated blood from the lower body to the heart.

Venous thrombosis. Blood clot in a vein.

Ventricular arrhythmia. Irregular rhythm of ventricular contractions.

Ventricular fibrillation. Arrhythmia that occurs when a series of uncoordinated impulses spread over the ventricles of the heart, causing them to twitch or quiver rather than contract.

Venules. Smallest veins; carry blood from capillaries to larger veins.

Vertical transmission. Route by which an infectious disease is transmitted from one generation to the next.

Vesicle. Small, fluid-filled sac (blister).

Vibrios. Comma-shaped bacterial cells.

Vitiligo. Loss of melanin resulting in white patches of skin.

Voluntary muscle. Striated muscle attached to bone and that is under conscious control.

Volvulus. Condition in which the intestine is twisted on itself.

Wernicke's encephalopathy. Brain disease, often associated with chronic alcoholism, in which the patient becomes mentally confused and disoriented and may suffer delirium tremens.

Western blot. Analytic technique that detects an antigen introducing its antibody into a sample of a patient's tissue.

Wheal. Localized elevation in the skin that is often accompanied by pruritis.

Wheezing. Sound of labored breathing as a result of narrowed tubes in the lungs.

Wilms' tumor. Malignant tumor of the kidney that develops in very young children.

Appendix B

Diagnostic Procedures and Laboratory Tests

Diagnostic Procedures

Angiography. Imaging test that uses x-rays to view blood vessels.

Biopsy. Sample of tissues taken to be examined microscopically to determine the presence or extent of a disease.

Blood chemistry test. Measures the levels of electrolytes in the blood.

Blood test. Examination of a sample of blood to determine its chemical, physical, or serologic characteristics.

Bone scan. Nuclear imaging test that helps diagnose and track several types of bone disease.

Breast exam. Physical exam of the breasts to check for lumps or other changes.

Bronchoscopy. Examination of the airway using a bronchoscope.

C-reactive protein test. Measures general levels of inflammation in the body.

Cardiac catheterization. Insertion of a catheter into a chamber or vessel of the heart.

Colonoscopy. Internal examination of the colon and rectum using a colonoscope.

Colposcopy. Examination of an illuminated, magnified view of the cervix and the tissues of the vagina and vulva.

Complete blood count (CBC). Measures the levels of different types of blood cells.

Computerized axial tomography scan (CAT scan or CT scan). X-ray procedure that combines many x-ray images with the aid of a computer to generate cross-sectional and three-dimensional views of the internal organs and structures of the body. A scan may require the use of a contrast material to improve visibility of tissues or blood vessels.

Culture. Microbiologic analysis of patient tissue or body fluids such as sputum, blood, or urine to isolate and identify potential pathogens.

Cytoscopy. Examination of the urethra and bladder using a cystoscope.

Digital rectal exam (DRE). Examination of the lower rectum that allows palpation of the prostate gland.

Doppler ultrasound. Measures blood flow and blood pressure by bouncing high-frequency sound waves off circulating red blood cells.

Echocardiography. Cardiac ultrasound.

Electrocardiogram (EKG or ECG). Measures the heart's electrical activity to help evaluate its function.

Electroencephalography (EEG). Detects electrical activity in the brain.

Electromyography (EMG). Assesses the health of muscles and the nerve cells that control them.

Endoscopy. Examination of the inside of the body using an endoscope.

Enzyme immunoassay (EIA). Uses an enzyme to label either the antibody or antigen.

Erythrocyte sedimentation tests. Measures general levels of inflammation in the body.

Flow cytometry. Identifies and counts cells that have a particular antigen.

Fluoroscopy. X-ray beam that is passed through the body. The image is transmitted to a monitor so that the body part and its motion can be seen in detail.

Gastroscopy. Examination of the upper gastrointestinal tract using an endoscope.

Genetic testing. Tests blood or other tissue to diagnose genetic diseases.

Hysteroscopy. Examination of the interior of the uterus using a hysteroscope.

Laproscopy. Thin, lighted tube inserted through an incision to view abdominal or pelvic organs.

Lumbar puncture (spinal tap). Small amount of cerebrospinal fluid that is removed and examined for the presence of microorganisms.

Magnetic resonance imaging (MRI). Uses a magnetic field and radio waves to create detailed images of organs and tissues.

Mammography. Low-dose x-ray used to examine breasts.

Pap test. Cells are collected from the cervix and examined for changes.

Pelvic exam. Includes inspection of the external genitalia, visual examination of the vagina and cervix

through a speculum, and palpation of the female internal organs.

Phonocardiography. Creates a graphic record, or phonocardiogram, of the sounds and murmurs produced by the contracting heart, including its valves and associated vessels.

Physical examination. Process of examining the body via inspection, palpation, auscultation, and percussion.

Plethysmography. Measures changes in the size of blood vessels by determining volume changes in the blood vessels of the eye, extremities, and neck or to measure gas volume changes in the lungs.

Positron emission tomography (PET) scan. Nuclear medicine imaging technique that produces a three-dimensional image or picture of functional processes in the body.

Prostate-specific antigen (PSA) test. Measures the level of PSA in the blood.

Qualitative nephelometry. Measures levels of IgG, IgA, and IgM.

Serum assay. Direct assessment of circulating hormones.

Serum electrolytes. Examination of blood serum to determine the levels of common electrolytes such as sodium, potassium, and chloride.

Spirometry. Measures lung volume by breathing into a spirometer.

Sputum analysis. Method of detecting certain infections by culturing sputum.

Stress test. Provides information about how your heart works during physical stress.

Stool analysis. Laboratory analysis that includes microscopic examination, chemical tests, and microbiologic tests.

Ultrasound. Produces sound waves that are beamed into the body causing return echoes that are recorded to visualize internal organs and monitor a developing fetus.

Urinalysis. Examination of the appearance, concentration, and content of urine.

Western blot. Detects an antigen using its antibody in patient serum.

X-ray. Type of radiation used in medical imaging and therapy.

Laboratory Tests

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
Ammonia (NH ₃) diffusion	20–120 mcg/dl	12–70 mmol/L	Abnormal levels of ammonia in the body are used to investigate severe changes in mood and consciousness and to help diagnose the cause of a coma of unknown origin.
Ammonia nitrogen	15–45 µg/dl	11–32 µmol/L	The test for ammonia nitrogen is nonspecific and does not indicate a cause. Higher than normal levels simply indicate the body is not effectively metabolizing and eliminating ammonia.
Amylase	35–118 IU/L	0.58–1.97 mkat/L	The normal level of amylase will depend on the method used to collect the data. An increased level may indicate several disorders of the digestive and reproductive systems or cancer of the pancreas. Tubal pregnancies will also cause a rise in the amylase levels. Decreased amylase levels may indicate damage to the pancreas and kidneys.

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
Anion gap ($\text{Na}^+ - [\text{Cl}^- + \text{HCO}_3^-]$) (P)	7–16 mEq/L	7–16 mmol/L	A determination of electrolytes in the blood fluid. Abnormal readings indicate a variety of factors. The test is nonspecific and only tells the physician that there is cause for additional testing. Some factors that cause an abnormal anion gap reading are uncontrolled diabetes, starvation, kidney damage, and ingestion of potentially toxic substances such as antifreeze, excessive amounts of aspirin, or methanol.
Bicarbonate			See <i>Carbon dioxide content</i> below
Arterial	21–28 mEq/L	21–28 mmol/L	
Venous	22–29 mEq/L	22–29 mmol/L	
Bilirubin			
Conjugated (direct)	0.2 mg/dl	4 mcmmol/L	
Total	0.1–1 mg/dl	2–18 mcmmol/L	Increased levels of bilirubin may be an indication of some kind of blockage of the liver or bile duct, hepatitis, trauma to the liver, a drug reaction, or long-term alcohol abuse or some inherited disorders (e.g., Gilbert's, Rotor's, Dubin-Johnson, and Crigler-Najjar), which will cause an increase in levels. Increased levels of bilirubin in newborns is a critical situation as excessive levels kill developing brain cells and may lead to mental retardation.
Calcitonin	< 100 pg/ml	< 100 ng/L	Increased levels of calcitonin in combination with a thyroid biopsy may be an indication of C-cell hyperplasia.
Calcium, total	8.6–10.3 mg/dl	2.2–2.74 mmol/L	
Calcium, ionized	4.4–5.1 mg/dl	1–1.3 mmol/L	Increased levels of calcium in the body indicate an inability to metabolize the intake. This can be due to several factors: hyperthyroidism, sarcoidosis, tuberculosis, excess vitamin D intake, kidney transplant, and high protein levels (e.g., if a tourniquet is used for too long while blood is collected). In this case, free or ionized calcium remains normal.
Carbon dioxide content (plasma)	21–32 mmol/L	21–32 mmol/L	Higher or lower than normal CO_2 levels indicate a problem losing or retaining fluid—disrupting the acid-base balance, which can be an indication of several disorders.
Carcinoembryonic antigen	< 3 ng/ml	< 3 mcg/L	CEA is a protein that is found in embryonic tissues. Increased CEA levels can indicate some non-cancer-related conditions of inflammation of internal organs. Pregnant women who smoke tend to have embryos that have increased levels of CEA. In a normally healthy infant all detectable levels of CEA are gone by birth.

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
Chloride	95–110 mEq/L	95–110 mmol/L	Increased levels of chloride may indicate dehydration or increased blood sodium. Decreased levels of chloride occurs with prolonged vomiting, chronic diarrhea, emphysema, or other chronic lung disease, and with loss of acid from the body.
Coagulation screen			Indicates an inability of the body to develop adequate clotting factors or the inability to produce the correct amount of clotting factors.
Bleeding time	3–9.5 min	180–570 sec	
Prothrombin time	10–13 sec	10–13 sec	
Partial thromboplastin time (activated)	22–37 sec	22–37 sec	
Protein C	0.7–1.4 µ/ml	700–1400 U/ml	
Protein S	0.7–1.4 µ/ml	700–1400 U/ml	
Copper, total	70–160 mcg/dl	11–25 µmol/L	Indication of liver disease.
Corticotropin (adrenocorticotrophic hormone [ACTH])—0800 hr	< 60 pg/ml	< 13.2 pmol/L	This test is used in conjunction with cortisol to determine if a patient has Cushing's syndrome or Addison's disease.
Cortisol 0800 hr	5–30 mcg/dl	138–810 nmol/L	Abnormal levels in cortisol may indicate Cushing's syndrome or Addison's disease.
1800 hr	2–15 mcg/dl	50–410 nmol/L	
2000 hr	50% of 0800 hr	50% of 0800 hr	
Creatine kinase			Creatine kinase is an enzyme found in the heart, brain, skeletal muscle, and other tissues. The body has specific types of CK to indicate which muscles are affected.
Female	20–170 IU/L	0.33–2.83 mkat/L	
Male	30–220 IU/L	0.5–3.67 mkat/L	
Creatinine kinase isoenzymes, MB fraction	0–12 IU/L	0–0.2 mkat/L	Depending on the ratio, the CK-MB fraction will indicate some form of muscle damage. The specific ratio can indicate if the muscle damage is cardiac or skeletal.
Creatinine	0.5–1.7 mg/dl	44–150 µmol/L	Increased creatinine levels indicate a disorder with kidney function. Creatinine can also increase temporarily as a result of muscle injury. Low levels of creatinine are not common. They may be seen in persons with decreased muscle mass, such as comatose patients. Normal pregnancy will cause the creatinine levels to drop and are not a cause for concern.
Erythrocyte count (RBC)			A low ESR can indicate polycythemia, extreme leukocytosis, and some protein abnormalities.
Female	$3.8\text{--}5.2 \times 10^6/\text{mcl}$	$3.8\text{--}5.2 \times 10^{12}/\text{L}$	
Male	$4.3\text{--}5.7 \times 10^6/\text{mcl}$	$4.3\text{--}5.7 \times 10^{12}/\text{L}$	

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
Erythrocyte sedimentation rate (sedrate, ESR)			Elevated ESR level is an indication of inflammation, anemia, infection, pregnancy, and advanced age.
Female	30 mm/hr	30 mm/hr	
Male	mm/hr	20 mm/hr	
Fibrinogen	200–400 mg/dl	2–4 g/L	Lower than normal fibrinogen levels indicate that the person may not be able to form a stable blood clot after injury. Chronically low levels may indicate an inherited condition such as afibrinogenemia, or to an acquired condition such as liver disease, malnutrition, or some types of cancer. Higher than normal levels of fibrinogen may indicate acute infections; breast, kidney, or stomach cancer; chronic DIC, inflammatory disorders; myocardial infarction; stroke; or trauma. Fibrinogen concentrations may rise sharply in any condition that causes inflammation or tissue damage.
Follicle-stimulating hormone (FSH)			Increased levels of FSH and LH (luteinizing hormone) are consistent with primary ovarian failure, which is when ovaries themselves fail. In men this may be an indication of testicular developmental defects or injury.
Female	2–13 mIU/ml	2–13 IU/L	
Midcycle	5–22 mIU/ml	5–22 IU/L	
Men	1–8 mIU/ml	1–8 IU/L	Decreased levels of FSH and LH are an indication of secondary ovarian failure, which results in problems with the pituitary or hypothalamic gland. In men this may be an indication of hypothalamic disorders.
Glucose, fasting	65–115 mg/dl	3.6–6.3 mmol/L	Indicates diabetes or prediabetes.
Glucose tolerance test (oral) 2 hour	(mg/dl)		Indicates diabetes or prediabetes.
Post-drink:	Normal fasting		
Impaired tolerance	65–99		
Indicates diabetes	< 140 mg/dl		
	140–199 mg/dl		
	> 200 mg/dl		
Haptoglobin	44–303 mg/dl	0.44–3.03 g/L	If the haptoglobin levels are decreased in combination with several other tests, it may be an indication of hemolytic anemia.
			Haptoglobin will be elevated in many inflammatory diseases, such as ulcerative colitis, acute rheumatic disease, heart attack, and severe infection.
Hematocrit (Hct)			Decreased hematocrit level indicates anemia, such as iron deficiency, but may have other causes such as vitamin or mineral deficiencies, recent bleeding, liver cirrhosis, and malignancies.
Female	35–46%	0.36–0.446	
Male	40.0–50.0%	0.4–0.503	

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
Hemoglobin A _{1c}	40.0–50.0% of total	0.053–0.075	Abnormally high levels of hematocrit may be an indication of dehydration and can be easily cured by increased fluid intake. <i>Polycythemia vera</i> —greater than normal number of red blood cells in a person can also cause a prolonged increase in the hematocrit levels. Higher than normal hematocrit levels are also seen in persons with chronic pulmonary conditions or lung damage. The person's bone marrow will increase production of red blood cells to supply the body with oxygen in response to a lacking pulmonary system.
Hemoglobin (Hb)			
Female	11.6–15.5 g/dl	121–153 g/L	Low levels of Hb are an indication of anemia. Some types of anemia are treated with iron, folic acid, or vitamin B ₁₂ or B ₆ supplements. It is normal for women of childbearing age to have temporary decreases during menstrual periods and pregnancy.
Male	13.7–16.7 g/dl	138–175 g/L	
Leukocyte count (WBC)	3800–9800/mcl	3.8–9.8 × 10 ⁹ /L	Infections usually cause increased WBC counts and may be treated with antibiotics. Leukemias (blood cancer) require chemotherapy and other treatments.
Leukocytes (WBC)			
Men	5000–10,000/mcL	5–10 × 10 ⁹ /L	Raised levels may indicate infection, inflammation, or cancer. Decreased levels may indicate autoimmune conditions, some severe infections, bone marrow failure, and congenital marrow aplasia. Decreased levels may also occur with certain medications such as methotrexate.
Women	4500–11,000/mcL (higher during pregnancy)	4.5–11 × 10 ⁹ /L	
Lymphocytes	of WBC		Chronic high levels may indicate lymphocytic leukemia.
Lipase	7–60 units/L @ 98.6°F (37°C)	7–60 units/L @ 98.6°F (37°C)	High lipase levels with abdominal pain may indicate acute pancreatitis, slightly raised levels can indicate kidney disease, salivary gland inflammation, or peptic ulcer disease.
Lipids			
Total cholesterol	< 200 mg/dl		A person with high cholesterol has more than twice the risk of coronary heart disease as someone whose cholesterol is below 200 mg/dL.
Borderline high	200–239 mg/dl		
High	240–above		
HDL			Low HDL is considered a major risk factor for heart disease.
High	> 60 mg/dl		
	< 40 mg/dl (men) < 50 mg/dl (women)		
LDL			If you don't have coronary heart disease or diabetes and have one or no risk factors, your LDL goal is less than 160 mg/dL.
High	< 100 mg/dl > 130 mg/dl		

Test	Normal value range (conventional)	Normal value range (SI units)	Possible indications
			<p>If you don't have coronary heart disease or diabetes and have two or more risk factors, your LDL goal is less than 130 mg/dL.</p> <p>If you do have coronary heart disease or diabetes, your LDL goal is less than 100 mg/dL.</p>
Triglycerides	>150 mg/dl		<p>Normal triglyceride levels vary by age and sex.</p> <p>A high triglyceride level combined with low HDL cholesterol or high LDL cholesterol seems to speed up atherosclerosis (the buildup of fatty deposits in artery walls). Atherosclerosis increases the risk for heart attack and stroke. (Info on lipids from the American Heart Association)</p>
High	> 200 mg/dl and above		
PSA			<p>PSA is a test indicating the level of protein cells the prostate is producing. The higher the PSA number, the more likely prostate cancer is present. Age, hormonal factors, and medications can alter the test results so a high PSA alone is not a cancer indicator.</p>
0–54 yrs	0.00–2.50 ng/ml		
55–59 yrs	0.00–3.40 ng/ml		
60–64 yrs	0.00–4.10 ng/ml		
65–69 yrs	0.00–5.10 ng/ml		
70 plus yrs	0.00–5.60 ng/ml		
TSH	0.40–5.00 IU/ml		<p>A high TSH result is often due to some type of acute or chronic thyroid dysfunction that causes the thyroid to be underactive. Although rare, a high TSH can be an indication of secondary hyperthyroidism, which is a problem with the pituitary gland.</p> <p>A low TSH result can indicate an over-active thyroid gland.</p>
Urea, plasma (BUN)	8.5–25 mg/dl	2.9–8.9 mmol/liter	<p>Increased BUN levels may be due to acute or chronic kidney disease, damage, or failure. Conditions that result in reduced blood flow to the kidneys, such as a recent heart attack, will also result in an increased BUN. Low BUN level is rarely detected because it results from diseases or symptoms, such as dehydration or starvation, that do not warrant a BUN test.</p>
Urinalysis pH	5.0–7.5	5.0–7.5	<p>Specific gravity is an indication of how well the kidneys are filtering waste products. Reduced specific gravity can indicate diabetes insipidus, certain renal diseases, excess fluid intake, or diabetes mellitus. Raised specific gravity can indicate dehydration, adrenal insufficiency, nephrosis, congestive cardiac failure, or liver disease.</p>
Specific gravity	1.001–1.030	1.001–1.030	

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Appendix C

Interactive Exercises

Chapter 1: Introduction to Disease

Answers to Cases for Critical Thinking

1. Abnormally high red blood cell counts can and do occur in well-trained athletes. Athletes develop increased cardiovascular efficiency and produce more red blood cells. Their hearts can handle the slightly increased viscosity of the blood and thus higher red blood cell levels may not be a sign of disease.
2. No. Many diseases share these symptoms. A simple history can determine if she ate recently or if she is under stress, depressed, or anxious, and a blood test can determine sugar levels and the presence of diabetes. The physician can consult a blood test to determine anemia or other blood disorders. A physical exam can determine whether she has hypertension. Cardiovascular abnormalities can be determined with a physical exam or with imaging techniques. In short, several diseases can explain these symptoms.
3. Many of the diseases are chronic. Education, screening, early diagnosis and treatment, and reduction of risk factors should have an impact on the prevalence of those diseases. Accidents are a significant cause of death. By applying the science of epidemiology to accidents, perhaps prevention can reduce mortality from accidents as well.
4. Obesity is the result of an energy imbalance; eating too many calories and not getting enough physical activity. Body weight may be the result of genetics, metabolism, behavior, environment, culture, and socioeconomic status. Behavior and environment are the key areas in obesity prevention.
5. In high-income countries people predominately die of chronic diseases. In low-income countries people predominately die of infectious diseases. In high-income countries research and resources should be directed toward chronic diseases. In low-income countries research and resources should be directed toward infectious disease.

Multiple Choice

1. a. sign
2. a. acute
3. d. etiology
4. a. health
5. b. exacerbation

True or False

1. False
2. True
3. False
4. True
5. True

Fill-Ins

1. prognosis
2. acute
3. idiopathic
4. relapse
5. remission

Chapter 2: Immunity and Disease

Answers to Cases for Critical Thinking

1. Tom did contract measles; he has produced antibodies against the rubella virus so his immune system has seen the rubella virus. Tom contracted measles recently because he has IgM against the rubella virus; IgM is the first antibody produced.
2. The bites happened after the women died because trauma is a trigger for inflammation and the bites were not inflamed.
3. IgA provides localized protection at mucosal surfaces such as the respiratory system.
4. Helper T cells stimulate antibody production by plasma cells, increase phagocytosis, and stimulate cytotoxic T cells and natural killer cells.

Multiple Choice

1. c. immunity
2. c. natural killer cells
3. a. humoral immunity
4. b. cell-mediated immunity
5. a. antigen
6. c. plasma cells
7. d. IV
8. a. IgE
9. c. helper T cells
10. d. helper T cells

True or False

1. False
2. False
3. True
4. True
5. False
6. False
7. True
8. True
9. False
10. False

Fill-Ins

1. phagocytosis
2. Interferons
3. Scleroderma
4. IgM
5. Nonspecific
6. Complement
7. Allergy or hypersensitivity
8. Hodgkin's lymphoma
9. HIV virus
10. Specific

Chapter 3: Infectious Diseases

Answers to Cases for Critical Thinking

1. Influenza is transmitted in respiratory droplets generated by coughing and sneezing. Isolation of flu patients would help decrease the transmission of the disease. Encouraging people to cover their noses and mouths when

they sneeze or cough would also help decrease transmission. To control the spread of malaria we must control the vector, the mosquito.

2. Viruses do not have the targets of antibiotics, cell walls and membranes, and metabolic and protein synthesis machinery. If antibiotics are used for viral infections, bacterial populations will more likely evolve resistance to those antibiotics.
3. Vaccines promote an immune response. The immunity acquired through vaccination produces antibodies and lymphocytes that respond to future exposures to the infectious agent. Because the immune response can stop an infection, the population as a whole can be protected from the infectious disease.
4. Whooping cough is caused by *Bordetella pertussis*. The bacteria are spread by direct contact with respiratory droplets. Antibiotics would be the treatment for this bacterial infection. There is a vaccine; whooping cough is part of the diphtheria, tetanus, pertussis vaccine.
5. Chickenpox is caused by the varicella zoster virus. The virus is spread by direct contact, droplet transmission, and airborne transmission. Treatment is supportive and may include treatments to control scratching, pain relievers, and fever reducers. A vaccine is available for varicella zoster.
6. Diphtheria, which is uncommon in the United States. Membranous coating in the throat is characteristic of this infection. Diagnosis is based on throat culture. Antibiotics would be the treatment for this bacterial infection.

Multiple Choice

1. d. cell wall
2. c. capsid
3. d. a nucleus
4. c. binary fission
5. d. protozoa
6. c. rubella virus
7. a. *Bordetella pertussis*
8. b. chitin
9. a. *Enterobius vermicularis*
10. d. a needlestick

True or False

1. True
2. False

3. False
4. True
5. True
6. True
7. False
8. True
9. False
10. False

Fill-Ins

1. normal flora
2. Reemerging
3. rubeola
4. Nosocomial
5. horizontal
6. cell membrane
7. Bacteria
8. Prions
9. paramyxovirus
10. varicella

Chapter 4: Cancer

Answers to Cases for Critical Thinking

1. In the United States, access to Pap test allows women to be screened for cervical cancer. In addition, the HPV vaccine is also available. Therefore, cervical cancer appears on the list of leading sites of cancer deaths worldwide but not on the list of leading sites of cancer deaths in the United States.
2. This would allow a researcher to determine if an experimental drug may be an appropriate treatment option for a cancer patient.
3. The answer to this question will vary depending on the genetics, environmental factors, and lifestyle choices of the student.
4. No. The American Cancer Society (ACS) recommends yearly mammograms starting at age 40 and continuing for as long as a woman is in good health. U.S. Preventive Services Task Force (USPSTF) mammogram recommendations can be found in the Prevention Plus! box in this chapter.
5. There is moderate or high certainty that the breast self-exam service has no net benefit or that the harms outweigh the benefits.

Multiple Choice

1. d. lipoma
2. c. muscle
3. c. hemorrhage
4. a. cyclins
5. a. radiation therapy
6. d. all of the above
7. c. infection with certain viruses
8. b. CT
9. c. very abnormal
10. b. node

True or False

1. True
2. True
3. True
4. False
5. False
6. True
7. True
8. True
9. True
10. False

Fill-Ins

1. bone
2. Tobacco use
3. Tumor markers
4. second
5. 30%
6. polyp
7. adenocarcinoma
8. Chemotherapy
9. uncontrolled
10. carcinogens

Chapter 5: Heredity and Disease

Answers to Cases for Critical Thinking

1. Turner's and Klinefelter's syndromes involve nondisjunction of an X sex chromosome, and either an egg or a sperm can donate an X sex chromosome. XXY involves nondisjunction of a Y sex chromosome; only the sperm donates a Y sex chromosome.

2. 50%. The chance of passing the dominant gene is about 50%.
3. 50% of male children have hemophilia A. 0% of female children have hemophilia A, but 50% will be carriers.
4. Hemochromatosis. Regular blood removal (donation) throughout life. At first a patient might donate two to three times per week and later once every 2–3 months. Chelation therapy is also available for those who cannot donate blood.

Multiple Choice

1. d. Both are autosomal dominant traits
2. b. 46
3. a. recessive
4. c. men have one X chromosome
5. b. Marfan syndrome
6. b. autosomal recessive
7. b. 50%
8. b. 25%
9. c. heterozygous
10. c. 44

True or False

1. True
2. True
3. False
4. False
5. False
6. False
7. False
8. False
9. True
10. True

Fill-Ins

1. Congenital
2. Hermaphrodites
3. Dominant
4. Connective tissue
5. Alleles
6. Polydactyly
7. Nondisjunction

8. 23
9. phenylketonuria (PKU)
10. gene therapy

Chapter 6: Diseases and Disorders of the Cardiovascular System

Answers to Cases for Critical Thinking

1. The heart or vascular diseases that should be considered for this patient include atherosclerosis, coronary heart disease, and myocarditis.
2. The heart diseases that should be considered for this patient include coronary heart disease, congestive heart disease, and myocarditis.
3. Smoking increases risk of atherosclerosis, chronic venous insufficiency, and cardiac arrhythmia. Diabetes increases risk of atherosclerosis, hypercholesterolemia, peripheral artery disease, and coronary heart disease.

Multiple Choice

1. c. lightheadedness
2. a. filling phase of the heart
3. d. LDL
4. b. carotid artery
5. a. atherosclerosis
6. b. angioplasty
7. b. between the left atrium and the left ventricle
8. d. sinoatrial node
9. a. myocarditis
10. c. autoimmune

True or False

1. True
2. True
3. False
4. False
5. False
6. False
7. True
8. True
9. False

Fill-Ins

1. thrombosis
2. atherosclerosis
3. Cardiomyopathy
4. Valvular stenosis
5. rheumatic fever
6. left ventricle
7. arrhythmia
8. defibrillator
9. ventricles
10. coronary

Chapter 7: Diseases and Disorders of the Blood

Answers to Cases for Critical Thinking

1. Anemia should be considered with this patient and weight loss occurs with gastrointestinal malabsorption, stress, and cancer. A blood test and health history will help confirm the diagnosis.
2. Thrombocytopenia, impaired synthesis of clotting factors, and vitamin K deficiency are to be considered. Symptoms to look for include prolonged bleeding, petechiae, and ecchymosis. Diagnostic tests include blood tests and bone marrow testing.

Multiple Choice

1. d. hemoglobin
2. d. folic acid
3. a. vitamin B₁₂
4. c. erythropoietin
5. c. hemoglobinopathy
6. b. thalassemia
7. a. polycythemia vera
8. d. Idiopathic thrombocytopenic purpura
9. c. Hemophilia A
10. b. Neutropenia

True or False

1. True
2. False
3. True

4. False
5. True
6. True
7. False
8. True
9. True
10. True

Fill-Ins

1. leukocytes
2. erythrocytes
3. hemoglobin S
4. platelets
5. alpha/beta
6. iron deficiency
7. anemia
8. 120
9. polycythemia vera
10. platelets

Chapter 8: Diseases and Disorders of the Respiratory System

Answers to Cases for Critical Thinking

1. Sheila probably has allergic rhinitis. A physical examination, medical history, and allergy testing are helpful in diagnosing allergic rhinitis.
2. Pulmonary embolism. Bill had a blood clot in his leg that broke loose and traveled to his lung where it is blocking an artery.
3. Sara should be able to pursue track and enjoy running because asthma can be managed with medicine and by avoiding triggers.

Multiple Choice

1. c. pleura
2. b. virus
3. d. pneumonia
4. c. emphysema
5. b. asthma
6. d. pneumothorax
7. a. lung

8. a. virus
9. a. bronchi
10. b. emphysema

True or False

1. True
2. False
3. False
4. True
5. False
6. False
7. False
8. False
9. False
10. True

Fill-Ins

1. Mantoux skin test
2. oxygen, carbon dioxide
3. cigarette smoking
4. spirometry
5. viruses
6. Pulmonary embolism
7. smoking
8. cilia
9. alveoli
10. cystic fibrosis

Chapter 9: Diseases and Disorders of the Gastrointestinal System

Answers to Cases for Critical Thinking

1. Gastroesophageal reflux disease (GERD) produces these symptoms. History should reveal a pattern of pain that follows meals and occurs at night or when prone. A physical exam can rule out little, but endoscopy can reveal abnormalities at the junction of the stomach and esophagus, such as a hiatal hernia. Treatment involves behavior changes such as taking smaller meals and avoiding food an hour before sleeping. Serious cases require surgical repair of the hiatal hernia.
2. Cholelithiasis (gallstones) causes these symptoms. If bile flow to the small intestine is blocked, dietary fat remains undigested and is not absorbed from the intestines. As a result, fat appears in the feces. Following a high-fat meal the gallbladder secretes bile into the small intestine. Gallstones lodge in the bile ducts and cause pain in the upper right abdomen.
3. In cirrhosis, normal liver tissue is replaced by scar or fat tissue, which does not function as normal liver tissue. Thus, the liver does not process the hemoglobin that comes from dying erythrocytes and the orange- and yellow-colored breakdown products build up in blood, tinting the skin and eyes yellow. Normal liver tissue processes carbohydrates and proteins and manufactures bile, which is used for fat absorption and the absorption of fat-soluble vitamins. The normal liver also manufactures clotting proteins. Finally, as blood flow through the liver is restricted by cirrhosis, abdominal and esophageal venous pressure increases, which leads to the distortion of the esophageal veins.

Multiple Choice

1. b. inflammation of stomach mucosa
2. b. ulcerative colitis
3. b. celiac disease
4. d. diverticulitis
5. d. The prognosis is good, with an 85% cure rate
6. c. It is most often caused by diabetes
7. b. chronic alcoholism
8. a. cirrhosis
9. a. *Candida albicans*
10. c. cholecystitis

True or False

1. False
2. True
3. False
4. True
5. True
6. False
7. False
8. False
9. False
10. True

Fill-Ins

1. amebic dysentery
2. Crohn's disease
3. hernia
4. endoscope
5. C
6. gallstones
7. gallbladder
8. ascites
9. mouth
10. large intestine

Chapter 10: Diseases and Disorders of the Urinary System

Answers to Cases for Critical Thinking

1. The pain is not normal during urination. Because of a short urethra, females are susceptible to urinary tract infections. This could be an infection of the urethra or the urinary bladder, which would cause painful urination with blood in the urine. The treatment is antibiotics.
2. Britany had developed edema because of glomerulonephritis that followed her streptococcal throat infection. Glomerulonephritis is a sequela of streptococcal infections of the throat and skin. The glomerular inflammation is caused by an antigen-antibody complex that impairs the filtration process. Treatment includes antibiotics and anti-inflammatories.
3. In an infant, this could be Wilm's tumor, a fast-acting malignant tumor of the kidney. However, the infant may also have an abdominal or inguinal hernia. Physical exam may help determine the location and nature of the mass. A CT will help image the mass. If a tumor, surgery, radiation, and chemotherapy are the treatments.
4. This patient has a renal tumor, and hematuria results from damage to the renal tissue. Surgery, radiation, and chemotherapy are the treatments.

Multiple Choice

1. d. complete lack of urine production
2. a. pyelonephritis
3. b. acute glomerulonephritis

4. d. uremia
5. b. symptoms include dysuria and urgency
6. a. peritoneal dialysis
7. b. dysuria
8. a. diabetic nephropathy
9. c. renal artery atherosclerosis
10. d. chronic glomerulonephritis

True or False

1. True
2. True
3. False
4. False
5. False
6. True
7. True
8. True
9. True
10. True

Fill-Ins

1. Pyuria
2. Diabetic nephropathy
3. kidney stones
4. Lithotripsy
5. Polycystic kidney disease
6. oliguria
7. urinary incontinence
8. hydroureters
9. dominant
10. Hematuria

Chapter 11: Diseases and Disorders of the Reproductive System

Answers to Cases for Critical Thinking

1. The condition is endometriosis; the etiology is idiopathic. Treatments include pain relievers, hormone therapy, and surgery.
2. Trichomoniasis is a possible diagnosis. Tests and procedures would include pelvic examination, microscopic visualization, culture, and

laboratory and pH tests. Antiparasitic medication is the available treatment.

3. Possible diagnoses include benign prostatic hyperplasia or prostate cancer. A digital-rectal examination, PSA test, and biopsy might be performed. Treatments include watchful waiting, surgery, and hormone therapy.
4. Decreasing transmission includes monogamy, use of condoms and dental dams, and regular pelvic exams. Taking antiviral medication on a regular basis may decrease transmission of the virus.
5. Because prostate cancer often grows very slowly, some men (especially those who are older or who have other major health problems) may never need treatment for their cancer.
6. Cryptorchidism is the name of the disease, and complications can include infertility and testicular cancer. Hormone therapy and surgery are possible treatments.

Multiple Choice

1. c. uterine fibroids
2. d. *Treponema pallidum*
3. c. Syphilis is only transmitted by sexual contact
4. a. chlamydia
5. d. menorrhagia
6. c. rectocele
7. b. dysmenorrhea
8. c. cryptorchidism
9. b. fimbriae
10. d. luteinizing hormone

True or False

1. True
2. False
3. True
4. False
5. True
6. True
7. True
8. True
9. False
10. False

Fill-Ins

1. seminiferous tubules
2. Orchitis

3. chlamydia
4. prostate gland
5. Prostatitis
6. Trichomoniasis
7. 1; 2
8. Cystocele
9. Amenorrhea
10. Erectile dysfunction

Chapter 12: Diseases and Disorders of the Endocrine System

Answers to Cases for Critical Thinking

1. Diabetes type 1 is consistent with age of onset, high urine production, and weight loss when the boy should be growing. It is possible that weight loss could be due to hyperthyroidism.
2. Cushing's syndrome is consistent with this history and these signs and symptoms.
3. A diabetic coma is consistent with this history and these signs and symptoms. Treatment with insulin is needed.

Multiple Choice

1. c. anterior pituitary
2. b. parathyroid hormone
3. b. Addison's disease
4. b. Cushing's disease
5. c. diabetes insipidus
6. a. Graves' disease
7. d. adrenal
8. a. Addison's disease
9. a. type 1 diabetes
10. c. thyroxine

True or False

1. True
2. False
3. False
4. False
5. False
6. False
7. False

8. True
9. True
10. True

Fill-Ins

1. gigantism
2. acromegaly
3. oxytocin, vasopressin
4. diabetes
5. Graves' disease
6. islet cells
7. adrenal
8. anterior pituitary
9. growth hormone
10. 2

Chapter 13: Diseases and Disorders of the Nervous System

Answers to Cases for Critical Thinking

1. J.A. has bacterial meningitis, which is a very serious, potentially fatal infectious disease. The signs and symptoms and lumbar puncture results all indicate meningitis. Treatment requires intravenous antibiotics, analgesics, and anti-inflammatories.
2. J.L. exhibits signs of dementia. A common cause of dementia is Alzheimer's disease, which is progressive and eventually fatal. To distinguish between the types of dementia, J.L. should visit his doctor for a complete evaluation and counseling.

Multiple Choice

1. b. virus
2. d. all of the above
3. d. heart rate and breathing
4. b. meningitis
5. a. caused by a virus
6. c. results from a damaged myelin sheath
7. a. ischemic stroke
8. b. Huntington's chorea
9. a. dopamine deficiency
10. c. epilepsy

True or False

1. True
2. True
3. True
4. True
5. False
6. False
7. True
8. False
9. False
10. True

Fill-Ins

1. Tetanus
2. lumbar puncture
3. Multiple sclerosis
4. Essential tremor
5. L-dopa
6. Encephalitis
7. folic acid
8. Bell's palsy
9. ALS
10. Antibiotics

Chapter 14: Diseases and Disorders of the Eye and Ear

Answers to Cases for Critical Thinking

1. Yes. Diabetes can damage the blood vessels in the back of the eye and result in impaired vision. However, J.R. may need eyeglasses to correct myopia, which is not related to diabetes. Myopia is an inherited problem in the length of the eyeball.

Elevated eyeball pressure may be a sign of glaucoma. The elevated pressure damages the retina and blood vessels and can cause blindness.

2. A.S. should wash her hands before handling her lenses. She should replace her contact lens case and fill it with new solution each night.

Pink eye (conjunctivitis) is usually bacterial and can be treated with antibiotic eye drops. Viral pink eye is not treated and usually resolves in about 2 weeks.

3. T.C. had a viral infection from the common cold that has spread into the middle ear (otitis media) and typically leads to a pus-forming bacterial infection. The doctor examines the ear drum externally using an otoscope to observe the tension on the tympanic membrane and notice any drainage. A warm heating pad gives some comfort and Tylenol (especially for children) is used to reduce pain and fever. Antibiotics kill bacteria and stop bacterial growth, and this (combination) regimen approach is usually a successful treatment process.

Multiple Choice

1. c. otitis media
2. d. keratitis
3. c. cataracts
4. c. myopia
5. c. glaucoma
6. c. hearing loss
7. a. presbycusis
8. c. tonometry
9. c. Meniere's disease
10. a. myopia

True or False

1. False
2. False
3. True
4. True
5. True
6. True
7. True
8. True
9. True
10. True

Fill-Ins

1. hearing
2. semicircular canals
3. pinna
4. tinnitus
5. retinoblastoma
6. cornea
7. cornea
8. Vertigo

9. cataracts
10. macular degeneration

Chapter 15: Mental Illness and Cognitive Disorders

Answers to Cases for Critical Thinking

1. Narcissistic personality.
2. Attention-deficit/hyperactivity disorder.
3. Posttraumatic stress disorder.

Multiple Choice

1. a. mood disorders
2. c. DSM
3. a. delusions
4. c. physical factors
5. c. personal weakness
6. a. movement
7. b. bulimia nervosa
8. d. having an active social life
9. d. major depressive disorder
10. a. paranoia

True or False

1. True
2. False
3. False
4. True
5. True
6. True
7. True
8. False
9. False
10. True

Fill-Ins

1. Anxiety disorders
2. Psychosis
3. Mental health
4. Hallucination
5. neurotransmitters
6. Bulimia nervosa
7. Delusions
8. Schizophrenia

9. mental status examination
10. psychotherapy

Chapter 16: Diseases and Disorders of the Musculoskeletal System

Answers to Cases for Critical Thinking

1. Osteoporosis is common in older women. Pain and height loss and kyphosis may all be due to vertebral fractures and bone loss. Calcium supplements and mild exercise such as walking with a cane or walker may increase muscle strength and thus prevent falls and fractures. Calcium-supplemented diet and weightbearing exercise throughout adolescence and adulthood can reduce risk of developing osteoporosis later in life.
2. History, physical exam, and occupation suggests osteoarthritis. The joints of the hand, fingers, hips, and knees are common sites of osteoarthritis. An x-ray or CT can show joint damage. Anti-inflammatories and analgesics are the medical treatments.
3. This young woman reports pain in her bone, not in her joint. This could be shin splints, which require rest. Bone infection would be accompanied by fever and systemic symptoms such as weakness. A tumor would also cause pain and weakness. An x-ray can rule out tumors and bloodwork can rule out infections.

Multiple Choice

1. c. vitamin D
2. d. the bones of adults
3. c. median nerve
4. d. Duchenne's MD
5. b. Osteoarthritis
6. a. rheumatoid arthritis
7. d. gout
8. c. osteogenic sarcoma
9. c. myasthenia gravis
10. c. osteomyelitis

True or False

1. True
2. False

3. True
4. True
5. False
6. True
7. True
8. False
9. False
10. True

Fill-Ins

1. *Mycobacterium tuberculosis*
2. rickets
3. osteoporosis
4. gout
5. calcium, phosphate
6. osteoblasts
7. synovial
8. myasthenia gravis
9. gout
10. calcium

Chapter 17: Diseases and Disorders of the Integumentary System

Answers to Cases for Critical Thinking

1. Impetigo is the diagnosis; *Staphylococcus aureus* or *Streptococcus pyogenes* are potential causes. Treatment is antibiotic medication.
2. Possible causes of the rash include tinea cruris, candidiasis, pediculosis, and scabies. Visual examination and culture are the diagnostic tests performed.
3. Basal cell carcinoma or squamous cell carcinoma are possible diagnoses; treatment includes a visual examination and biopsy.
4. Hormones, overproduction of sebum, bacteria, lack of or uneven exfoliation of skin cells. Treatment may include topical antibiotics and antibacterials, retinoid, oral antibiotics, oral contraceptives, and isotretinoin. Prevention of acne includes not overcleansing the skin, not using harsh scrubs, avoiding products with high concentrations of alcohol, and keeping the hands away from the face.
5. Cold sores caused by the herpes simplex type I virus. HSV-1 is spread by kissing, close contact

with herpetic lesions, or contact with skin that is shedding the virus. Antiviral drugs are the treatment of choice.

6. The hard, thick patches are likely plantar warts, caused by human papillomavirus.

Multiple Choice

1. d. vesicle
2. b. macule
3. b. cyst
4. a. epidermis
5. c. white
6. c. subcutaneous tissue
7. c. papules
8. c. hair follicles
9. a. parasitic
10. c. Sebum

True or False

1. False
2. False

3. False
4. False
5. True
6. False
7. False
8. False
9. True
10. False

Fill-Ins

1. Melanin
2. Pediculosis
3. dermis
4. wheal or hive
5. Scabies
6. Psoriasis
7. Contusions
8. Hemangioma
9. Vitiligo
10. Tinea pedis

Appendix D

Prevention Plus Suggested Answers

Chapter 1: Introduction to Disease

Four Modifiable Risk Factors for Chronic Disease

1. Four modifiable risk factors for chronic disease are lack of physical activity, poor nutrition, tobacco use, and excessive alcohol consumption.
2. Moderate alcohol consumption is defined as two drinks a day for men, one for women.
3. You should engage in strength and flexibility training two times per week.
4. An adult needs 75 minutes per week of vigorous-intensity aerobic activity.
5. Half your healthy plate should be fruits and vegetables.

Chapter 2: Immunity and Disease

Epinephrine Treatment for Life-Threatening Allergic Reactions

1. Epinephrine is a prescription medication because it could be dangerous if injected when not suffering from a life-threatening allergic reaction. It constricts blood vessels to increase blood pressure and increases heart rate.
2. Injection of epinephrine into the thigh muscle offers the fastest systemic absorption. When suffering life-threatening anaphylaxis the speed at which epinephrine is absorbed is critical. If not absorbed quickly, the patient could die before adequate levels of epinephrine are achieved.

FDA Approves HIV Preventative Drug

1. No, the HIV preventative drug is not a cure. It decreases the amount of HIV virus in the body.
2. No, the HIV preventative drug is not a substitute for safer sex practices. The HIV preventative drug is used along with consistent and correct condom usage.

Chapter 3: Infectious Diseases

Advice for Travelers

1. The immune response takes from 10 days to 2 weeks to reach its peak because after initial exposure to the antigen, lymphocytes need to become activated, reproduce, and develop. You should get a vaccine appropriate for your destination at least 2 weeks before your trip.
2. Many people in the United States are vaccinated against childhood illnesses such as measles, pertussis, and chickenpox. Your relative will not need to worry about contracting such diseases. While in the United States, your relative should take the same precautions that you do to protect from infectious diseases.

Chapter 4: Cancer

Recommended Cancer Screenings

1. According to the U.S. Preventative Services Task Force (USPSTF), women should start getting mammograms at age 50.
2. USPSTF does not recommend yearly mammograms for women of any age.
3. Men and women should begin colorectal cancer screening at age 50.

Chapter 5: Heredity and Disease

Huntington's Disease

1. The man whose father had Huntington's disease should be concerned about passing the disease along to his child because there is approximately 50% chance that he inherited the dominant gene for Huntington's from his father. In fact, if he inherited the gene, he will become sick, too.
2. The man whose father had Huntington's disease will know if he carries the disease by taking a genetic test that detects the presence of the faulty gene.

Chapter 6: Diseases and Disorders of the Cardiovascular System

Risk Factors for Coronary Heart Disease

1. Modifiable risk factors for coronary heart disease include diet, exercise, and smoking. Non-modifiable factors include genetics, metabolic rate, and personality.
2. While genetics may predispose a person for disease, that person can reduce risk by eliminating behavioral and environmental factors.

Chapter 7: Diseases and Disorders of the Blood

Anemia and Vegetarians

1. Fruits and vegetables contain less iron than meat. Iron is required for the synthesis of hemoglobin, so vegetarians are at risk for developing iron-deficiency anemia.
2. Meat contains heme iron, which is more easily absorbed than nonheme iron found in plants.
3. Children need protein as well as iron and B₁₂. To obtain iron and B₁₂, they need to eat a variety of fruits, beans, and vegetables. Beans also provide protein as do foods such as eggs, peanut butter, Greek yogurt, cottage cheese, and soy milk.

Chapter 8: Diseases and Disorders of the Respiratory System

Appropriate Antibiotic Use

1. No. Antibiotics affect bacteria, not viruses, so they are not an appropriate treatment for a viral infection.
2. No. A cold is caused by a virus and will not be helped by taking an antibiotic.
3. No. The influenza virus causes flu, so an antibiotic should not be taken to treat flu.

Chapter 9: Diseases and Disorders of the Gastrointestinal System

Bacteria, Coolers, and Food Poisoning

1. At cold temperatures the chemical reactions of metabolism slow down too much to sustain life. However, the cold temperature does not damage the bacterial cell, its molecules, or metabolic machinery, so when temperatures increase, bacteria can grow again.
2. At extreme temperatures like those used for cooking food, heat destroys bacterial cells, their molecules, and metabolic machinery.

Cancer Prevention through Detection

1. Precancerous polyps and cancer normally arise in mature adults. Therefore the benefits of screening for colorectal cancer outweigh the risks after approximately age 50.
2. Young people should be screened if they have a family history of colon cancer, familial polyposis, or if they exhibit signs and symptoms that suggest colon cancer.

Know Your Viruses

1. Handwashing can prevent hepatitis A. Workers in the food service industry must use sanitary procedures when handling food, including the simple task of washing their hands. You can protect yourself at home by thoroughly cooking meat and seafood.
2. Blood transmits hepatitis B and C. Health care workers receive vaccination against hepatitis B, and blood is screened for contamination by hepatitis B and C.

Chapter 10: Diseases and Disorders of the Urinary System

Chronic Kidney Disease

1. The thick and rigid arteries that develop with atherosclerosis reduce blood flow and filtration, thereby contributing to kidney disease.
2. Diet can affect blood pressure, which affects kidney function.

Chapter 11: Diseases and Disorders of the Reproductive System

Self-Screening for Breast Cancer

1. A woman should do a breast self-exam once a month.
2. A self-exam may detect something you think may be abnormal that should be checked in a clinical breast exam. A clinical breast exam is performed by a health care professional who is trained to recognize many different types of abnormalities and warning signs. This in-office exam will most likely be completed by your family physician or gynecologist at your annual visit.

Preventing STIs

1. The best way to prevent sexually transmitted infections (STIs) is abstinence.
2. You and a new partner should get tested for STIs before you begin a sexual relationship.

Chapter 12: Diseases and Disorders of the Endocrine System

Diabetes Control

1. You should do 30 minutes of physical activity most days of the week.
2. True. A 5% weight loss will help you better manage your blood glucose level.

Chapter 13: Diseases and Disorders of the Nervous System

Head and Neck Injuries Are Preventable

1. Help convince a motorcycle rider to wear a helmet by explaining that motorcycle accidents are a leading cause of traumatic brain injury. A helmet reduces the risk of brain injury and death in the event of an accident.

2. In addition to motorcycle riding, bicycling, skateboarding, rock climbing, snowboarding, and rollerblading all require head and neck protection.
3. Swelling impairs nerve function. When inflammation from spinal injury subsides, sometimes nerve function recovers.

Chapter 14: Diseases and Disorders of the Eye and Ear

Turn Down the Volume

1. Repeated exposure to loud noises can destroy hair cells in the inner ear, leading to hearing loss.
2. A tuning fork test can determine if there is a conduction problem due to an ear ossicle problem.

Chapter 15: Mental Illness and Cognitive Disorders

Exercise and Mental Disorders

1. Endorphins are released in the brain during exercise.
2. Endorphins make you feel euphoric and satisfied.
3. Exercise also boosts self-esteem.

Chapter 16: Diseases and Disorders of the Musculoskeletal System

Bones, Joints, and Muscles Benefit from Exercise

1. Moderate exercise strengthens bones, joints, and muscles, maintaining flexibility. Exercise promotes bone density.
2. A person with arthritis will benefit from moderate low impact exercise such as walking, swimming, or bicycling.

Carpal Tunnel Syndrome: An Occupational Hazard

1. Ergonomic positioning of hands while typing can prevent carpal tunnel injury. Rest, stretching, and ice can reduce inflammation.
2. If rest, ice, and anti-inflammatory medications are ineffective in relieving carpal tunnel injury, surgery may be performed to relieve pressure on the median nerve.

Chapter 17: Diseases and Disorders of the Integumentary System

Examining Your Skin

1. You should examine your skin once a month.
2. You should examine *all* of your skin, from head to toe.

Skin Cancer Prevention Tips

1. The most important way to lower your risk for skin cancer is to limit your exposure to ultra-violet (UV) radiation.
2. You should see your physician for a professional skin exam once a year.

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